United States
Environmental
Protection Agency

US Army Corps
Of Engineers
New England District
696 Virginia Road
Concord, MA 01742-2751

LONG ISLAND SOUND DREDGED MATERIAL DISPOSAL EIS

Analysis of Connecticut Department of Environmental Protection Trawl Data for Long Island Sound

November, 2001

LIS-2001-A09-FC1

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1.0 INTRODUCTION

The U.S. Environmental Protection Agency (USEPA) Region 1, with assistance from the U.S. Army Corps of Engineers, New England District (USACE), has initiated the preparation of a comprehensive Environmental Impact Statement (EIS) in compliance with the National Environmental Policy Act (NEPA). The EIS will consider the potential designation of one or more dredged material disposal sites in the waters of Long Island Sound (LIS) consistent with the provisions of Section 102c of the Marine Protection Research and Sanctuaries Act (MPRSA) and 40 CFR 230.80 of EPA's regulations under Section 404 of the Clean Water Act.

To support the preparation of the EIS, data were obtained from the Connecticut Department of Environmental Protection, Fisheries Division to assist in evaluation of fish resources in Long Island Sound. The objective of a series of related tasks was to acquire, compile, organize and analyze historical trawl data (1984-2000) from LIS to evaluate relative abundance and richness of finfish and selected invertebrate species. The specific objectives were to:

1. Develop a database compatible with Geographic Information System (GIS) analysis and with a structure that permits queries and reports suitable for data evaluation relevant to EIS requirements.

2. Analyze the data to compare results from the four existing dredged material disposal sites to comparable strata within LIS. The following parameters were requested:

    a. Total Catch Per Unit Effort (CPUE).

    b. Richness (finfish+squid+lobster).

    c. Species CPUE of a group of selected species (see below).

    d. Total Harvestable CPUE of commercial/recreational species.

    e. Species CPUE of juveniles and young of year (if available) of selected species.

The database has been delivered separately, but all of the results presented in this report were derived from the database and associated GIS analyses. Queries were developed and utilized to group, filter and calculate data parameters in the groups and strata described below. These queries and associated GIS routines will also be used for screening of potential alternatives during site selection and establishment of impact criteria for each prospective site. Additional data outside of Long Island Sound has been obtained by Rhode Island Department of Environmental Management and the National Marine Fisheries Service (Block Island Sound) and will be incorporated into the EIS but is not presented in this report.

This report presents an analysis of the CTDEP trawl survey results in relation to the four existing dredged material disposal sites: Western Long Island Sound (WLIS); Central Long Island Sound (CLIS); Cornfield Shoals Disposal Site (CSDS); and New London Disposal Site (NLDS). This approach permits not only comparison of existing conditions at these sites, but also consideration of fish resources over a time period during which disposal activity has occurred at all of these sites. Trawl stations were classified by depth, sediment type and location into habitat areas and compared to trawl stations located within the vicinity of each of the four disposal sites (detailed approach described below, see Figure 1.0-1 for locations). The level of disposal activity at existing sites is best represented by the disposal logs kept by the Disposal Area Monitoring System (DAMOS) of the New England District of the U.S. Army Corps of Engineers (Figure 1.0-2, Thomas Fredette, personal communication 2001). These logs represent estimates of barge volumes recorded by inspectors during disposal activity. The time series is presented from 1982-2000 to permit comparison of disposal activity from just before the trawl survey throughout the period discussed in this report. Fish resource parameters were calculated from CTDEP data and grouped by:

- habitat areas
- disposal site analysis areas (WLIS, CLIS, CSDS, NLDS)
- seasons (fall, spring)
- years (1984-2000)
- trawl stations
- selected species

Our approach to the analysis and interpretation of the spatial and temporal patterns of abundance and richness relied extensively on the experience and knowledge of the staff of CTDEP Fisheries Division, NYSDEC Marine Fisheries, and Michael Ludwig of National Marine Fisheries Service. In particular, we used the following report as the primary source for data structure and interpretation:

Gottschall, Kurt F., Mark W. Johnson, David G. Simpson. 2000. The Distribution and Size Composition of Finfish, American Lobster, and Long-Finned Squid in Long Island Sound based on the Connecticut Fisheries Division Bottom Trawl Survey, 1984-1994. U.S. Department of Commerce, NOAA Technical Report NMFS 148, 195 p.

However, any omissions, mistakes or errors in judgment are the responsibility of the authors of this report.

FIGURE 1.0-1 LOCATION OF DISPOSAL SITES AND LANDMARKS IN LONG ISLAND SOUND (Disposal Site Sizes Vary)

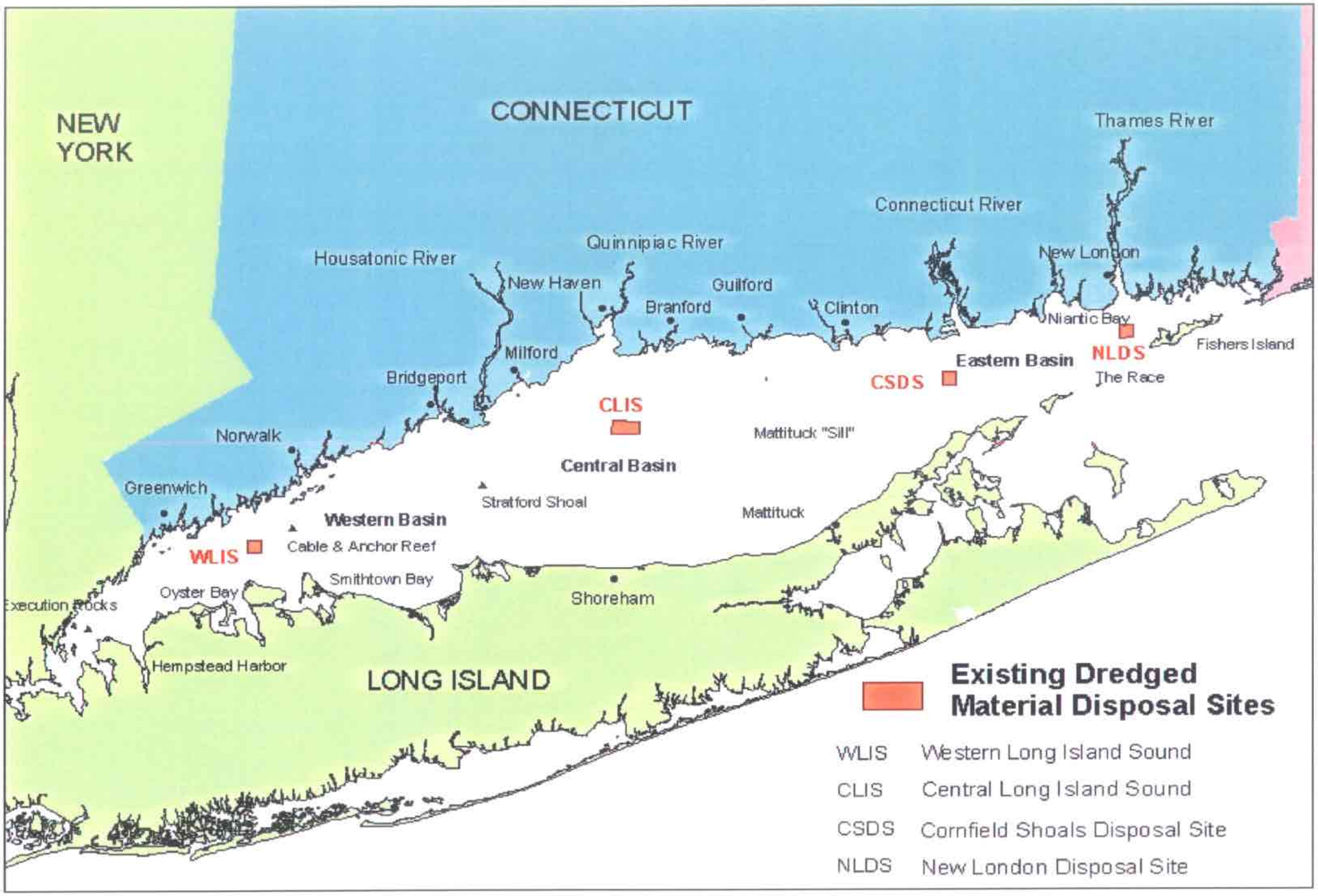

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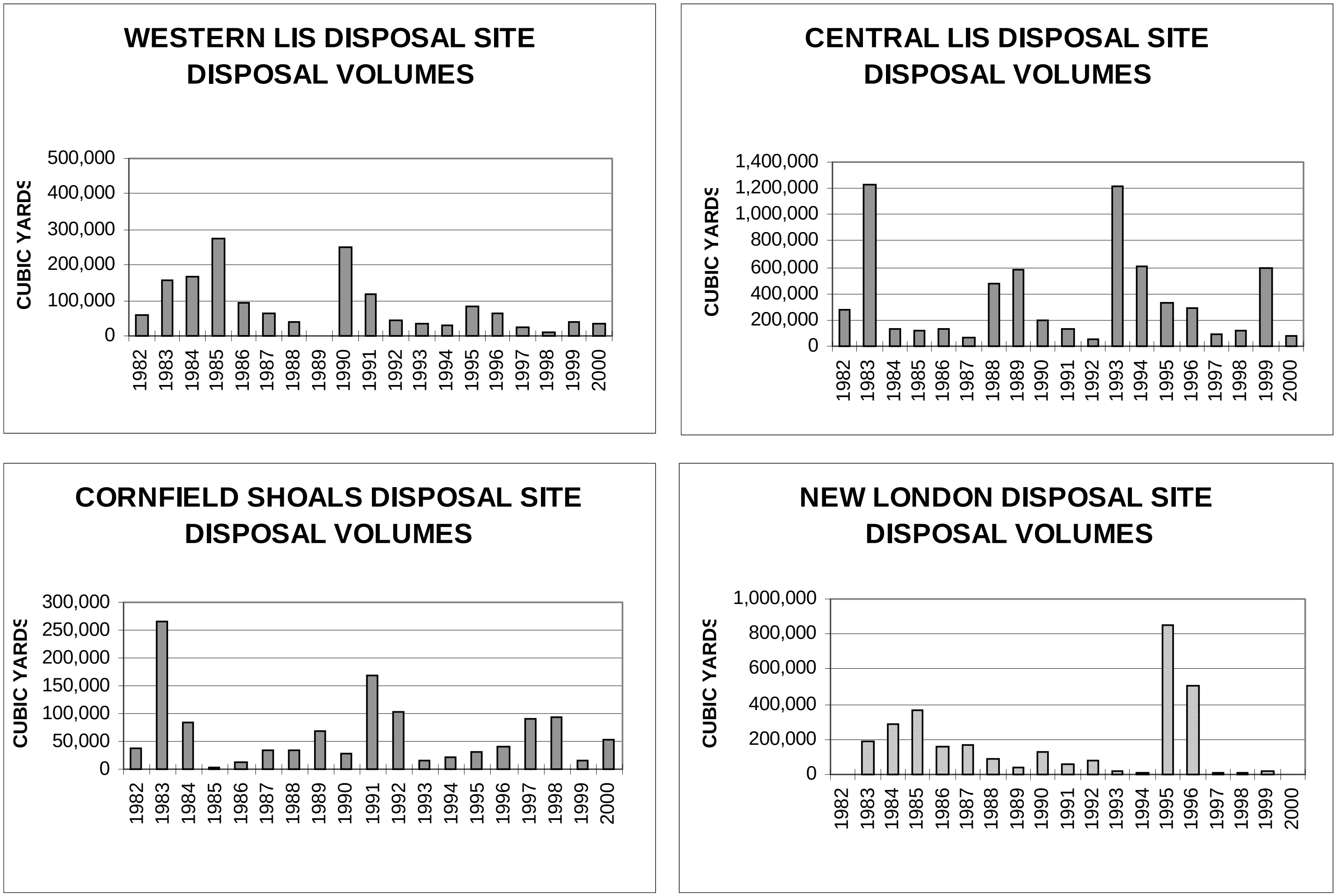
FIGURE 1.0-2 ANNUAL DISPOSAL VOLUMES AT LONG ISLAND SOUND DREDGED MATERIAL DISPOSAL SITES, 1982-2000. Disposal Volumes from DAMOS Disposal Log Database (Estimated Barge Volumes, Thomas Fredette, Personal Communication, 2001)



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This report is structured to present the results in four distinct sections. First, spatial distribution of fish resource parameters are described and presented. This is the primary method of comparing results from habitat areas with disposal site analysis areas. Second, the seasonal distribution of fish resources is described and presented. All data were grouped into spring (April-June) or fall (September-October) clusters as these seasons were sampled consistently throughout the analysis period. Strong seasonal patterns of fish distribution are apparent in Long Island Sound (LIS) and these must be considered in the spatial and temporal analyses. Third, the distribution and long term trends in abundance of selected species is described and presented. In order to account for the specific variations in total CPUE and richness and describe potential impacts, species patterns were analyzed. Where available, juvenile and young of year (YOY) data are presented to identify potential nursery habitat. Fourth, the distribution of harvestable lengths (i.e. fish large enough to harvested by commercial or recreational fishers) is described and presented to evaluate potential impacts on commercial and recreational fishing.

2.0 METHODS

2.1 DATA COLLECTION

The data were collected in a trawl survey of Long Island Sound conducted by the Connecticut Department of Environmental Protection (CTDEP) between 1984 and 2000 (Gottschall et al. 2000). The trawl survey occurred in water depths ranging from 5 to 46 m and covered an area between Groton, Connecticut (72^{o}03’W) and Hempstead Harbor, New York (73^{o}43’W). The CTDEP divided the sampling area into 1.85 x 3.7 km (1 x 2 nm) rectangles and randomly sampled among these **stations** (CTDEP “sites”[*]*) in monthly cruises of 40 stations each. Of the 525 defined stations, 311 have been successfully trawled during this period. Each station was also classified into one of 12 **strata** based on four depth intervals (< 9.1 m, 9.1 – 18.2 m, 18.3 – 27.3m, or >27.3m), and three bottom types (mud, sand, or transitional sediments). Sediments were classified according to Reid et al. (1979) as sand (<5% silt/clay), transition (5-50% silt/clay) and mud (>50% silt/clay). More recent intensive sampling by other investigators has revealed more detailed sediment distributions (e.g., Knebel and Poppe 2000, Poppe et al. 2000) however, to retain comparability with Gottschall et al. (2000) we used the more general classification scheme adopted by CTDEP (Figure 2.1-1).

From 1984 to 1990, sampling occurred from April through November. In 1991, the CTDEP began sampling only in the spring (April-June) and fall (September-October). A third cruise of 40 sites was added in 1993, which occurred from late September through early October. Specific details about gear and gear deployment are contained in Gottschall et al. (2000). After each tow, CTDEP staff sorted the catch by species and recorded total counts for each species. Total and fork lengths (cm) were measured on seven species of recreationally important finfish: bluefish, scup, striped bass, summer flounder, tautog, weakfish, and winter flounder. Other species were also measured in the trawl survey on a variable basis depending on research needs and priorities. In total, length data have been obtained from 36 species since the survey began.

2.2 APPROACH TO DATA ANALYSIS

In order to evaluate the data for potential impacts of disposal of dredged material on fish resources “disposal site analysis areas” were defined around each existing dredged material disposal site (Figure 2.1-1). Disposal activity has taken place at each disposal site throughout the survey period (1984-2000)

[*] The term “station” is used to distinguish sampling locations from disposal sites; our stations are synonymous with CTDEP’s sites.

and prior to the survey period (Figure 1.0-2 and USACE and USEPA 1998). This disposal activity represents a potential impact on fish resources through direct disturbance of seafloor sediments, transient disturbance of the water column (increased suspended sediment and release of trapped porewater) and indirect disturbance of demersal and pelagic communities (avoidance or attraction to disturbed sediments and water column) (Fredette et al. 1993, USACE and USEPA 1998). To assess these potential impacts on highly mobile resources an analysis area several times larger than the disposal sites is required. For this dataset, two additional mitigating factors are present. First, the trawl survey does not sample directly within the existing disposal sites (to avoid gear entanglement and disruption of disposal activity). Second, the random distribution of 40 seasonal stations over 311 potential sampling locations does not ensure frequent sampling of stations adjacent to disposal sites.

2.2.1 Disposal Site Analysis Areas

In order to address the needs for: sufficient sample size, relevance to disposal activity, and wide scope of fish movements, **disposal site analysis areas** were defined as 6 x 3 nautical mile (nmi) rectangles surrounding each existing disposal site. In practice, these rectangles enclose up to a maximum of 16 trawl stations (CLIS) and a minimum of five (NLDS) due to restrictions on trawling in some areas (Figure 2.1-1). The analysis areas were elongated east-west to account for the prevailing tidal currents at each site (USACE and USEPA 1998, Signell et al. 2000) assuming some movement of fish and suspended sediments is enhanced by these currents. Within each analysis area, stations were grouped by the dominant habitat type (see below) and all other habitat types to permit potential comparative assessment of species with affinity for specific strata (depth and sediment type).

2.2.2 Habitat Areas

To assess habitat utilization within different areas of LIS, CTDEP divided their sampling grid into 14 plots, or habitats (Gottschall et al. 2000). Each habitat area comprised contiguous sampling stations with similar depth and sediment strata characteristics (Figure 2.2-1). We extended the **habitat areas** into western LIS to account for additional sampling efforts conducted in 2000. Using the approach of Gottschall et al. (2000), we selected contiguous stations with a single sediment type and depth intervals above and below 18 m (shallow or deep). These contiguous stations were grouped into four new habitat areas (habitat areas 15-18, Table 2.2-1). In addition to the grouping of stations, we grouped the habitat areas by characteristics into six types and examined their distribution within LIS (Table 2.2-2 and Figure 2.2-1).

Western LIS now has seven habitat areas all within eight nmi of WLIS. The southern shore has shallow transitional, shallow sand; and the north shore shallow mud. The center habitats reflect the two-part nature of the western basin with shallow mud in the west through deep mud, shallow transitional over the cable and anchor reef to deep mud in the east. Much of the Western Basin has been difficult to trawl prior to 1999 because of the high density of lobster gear. In 2000, almost all of this gear was absent due to the catastrophic mortality of lobsters in LIS. As part of the effort to assess the resource, CTDEP conducted additional trawls in this area and provided most of the data on finfish from this one year. Central LIS has eight habitat areas; all but one within twelve nmi of CLIS. The northern shore shifts between shallow mud and transitional, while the center shifts from deep mud to transitional to sand to the east. The most remote habitat area (10) is a shallow transitional area off Mattituck. Eastern LIS has four habitat areas, three within two nmi of CSDS and two within two nmi of NLDS. Because much of this area is difficult to trawl, there are a relatively small number of stations that have been occupied. There are no mud habitat areas in eastern LIS. Deep and shallow sand occurs in the western portion of this region near CSDS and deep and shallow transitional habitats occur near NLDS.

Because of the varying density of trawl stations and habitat areas in each of the basins of LIS, our comparative approach was tailored for each disposal site analysis area. In each case, we selected the habitat area that was most dominant within the analysis area and used that as our primary comparison (Table 2.2-3). For WLIS the very small sample numbers would permit only a qualitative assessment of the relationships between disposal site analysis areas and habitat areas. For CLIS, the large sample numbers and diversity of habitat areas allowed comparison of three clusters: all of CLIS (the analysis area); CLIS-7 (the stations from habitat area 7); and CLIS-5, 6,9 (the stations from habitat areas 5, 6, and 9). For CLIS, habitat areas 5, 6, and 9 all occur within the CLIS disposal site analysis area and were grouped to allow sufficient data for comparison. For CSDS, the analysis area was deliberately skewed to the south to reflect the deep sand nature of this disposal site. In this case, a useful comparison can also be made with the surrounding habitat areas due to the relatively small catch and transient nature of many of the species (D. Simpson pers. comm. 2001). For NLDS, the lack of sampling in this region is a result of very patchy trawl areas best known to local fishermen. While the shallow transitional habitat area 13 probably best reflects the conditions at the disposal site, this habitat is strongly influenced by nearshore conditions and may not provide an accurate comparison with NLDS. However, most of the commercial finfishing activity near NLDS is conducted in Niantic Bay so this habitat area is of strong interest.

2.2.3 <u>Database Organization</u>

The CTDEP trawl survey SAS software database was imported into a Microsoft Access database to execute data analyses. The database was filtered to include only spring (April – June) and fall (September – October) tows. The CT DEP ceased sampling in the months of July, August, and November after 1990, leaving fewer samples to compare with samples obtained in the other months. The disposal of dredged material in LIS is generally conducted between 1 October and 31 May due to restrictions on dredging harbors and rivers during spawning season (Fredette et al. 1993, USACE and USEPA 1998). Our primary objective was to evaluate potential impacts from dredged material disposal on fish resources and the highest potential impacts would likely be during the periods of high activity for fish and disposal (spring and fall). All of the results discussed below are based on monthly sampling in April, May, June, September, and October. The database is structured with queries to sort data records by year, season, species, habitat area, analysis area, and sampling station. Indices described below were calculated in Access and exported to Excel and ArcView for development of charts and maps.

Lobster, squid, and a selection of finfish species were chosen as "selected species" to examine more closely in the analyses (Table 2.2-4). These species were selected based on the relative amount of species-specific abundance data, commercial or recreational importance, and ecological significance (i.e., bottom-oriented, lengthy residence in LIS). The selection list was reviewed by fisheries and marine science staff of CTDEP, NYSDEC, NMFS, FWS, USEPA, and USACE. The final list reflected the collective judgment of all parties; a more extensive list will be available for site screening and assessment through the database deliverable.

TABLE 2.2-1 HABITAT AREA DESCRIPTIONS

Habitat Area	Acronym	Name	Sediment Type	Depth M	Location
1	SMW	Shallow Mud West	Mud	<18	Bridgeport to Norwalk
2	DMW	Deep Mud Western Basin	Mud	>18	Western Basin East: Cable & Anchor Reef to Stratford Shoal
3	STSW	Shallow Trans.Sand West	Transitional and Sand	<18	Smithtown Bay
4	SMC	Shallow Mud North	Mud	<18	Milford to New Haven
5	STC	Shallow Trans. North	Transitional	<18	Milford to New Haven
6	SMC	Shallow Mud Central	Mud	<18	Branford
7	DMC	Deep Mud Central	Mud	>18	Central Basin
8	STC	Shallow Trans. Central	Transitional	<18	Guilford
9	DTC	Deep Trans. Central	Transitional	>18	Central Basin East Mattituck Sill
10	STC	Shallow Trans. South	Transitional	<18	Mattituck
11	DSE	Deep Sand East	Sand	>18	Mattituck Sill
12	SSE	Shallow Sand North	Sand	<18	Long Sand Shoal
13	STE	Shallow Trans. East	Transitional	<18	Niantic Bay to New London
14	DTE	Deep Trans. East	Transitional	>18	Eastern Basin
15	DMW	Deep Mud West	Mud	>18	Greenwich Pt. to Cable & Anchor Reef
16	DTW	Deep Trans. West	Transitional	>18	Cable & Anchor Reef
17	SMW	Shallow Mud West	Mud	<18	Western Basin West Execution Rocks to Greenwich Pt.
18	STW	Shallow Trans. West	Transitional	<18	Hempstead to Oyster Bay

TABLE 2.2-2   HABITAT AREA CHARACTERISTICS AND DISTRIBUTION

Habitat Area Characteristics	Total Number of Habitat Areas	Habitat Areas		
		West	Central	East
Shallow Sand	2	3		12
Deep Sand	1		11	11 CSDS
Shallow Transitional	6	3, 18	5, 8, 10	13 NLDS
Deep Transitional	3	16	9	14
Shallow Mud	4	1, 17	4, 6	
Deep Mud	3	2, 15 WLIS	7 CLIS	
Totals	19 Habitat Areas (Habitat area 3 has two characteristics)	7 Habitat Areas	8 Habitat Areas	4 Habitat Areas

TABLE 2.2-3 HABITAT AREA COMPARISONS WITH DISPOSAL SITE ANALYSIS AREAS

Disposal Site Analysis Area	Primary Habitat Area Number: Characteristic	Secondary Habitat Areas Number: Characteristic
WLIS (5 stations one year)	15:Deep Mud (3 stations)	16:Deep Transitional (2 stations)
CLIS (16 stations)	7:Deep Mud (10 stations)	5:Shallow Transitional (2 stations) 6:Shallow Mud (3 stations) 9:Deep Transitional (1 station)
CSDS (9 stations)	11:Deep Sand (5 stations)	12:Shallow Sand (2 stations) 14:Deep Transitional (2 stations)
NLDS (5 stations)	13:Shallow Transitional (4 stations)	14:Deep Transitional (1 station)

TABLE 2.2-4 SELECTED SPECIES LIST FOR ANALYSIS

Common Name	**Database Abbreviation**	**Scientific Name**
Alewife	ALW	*Alosa pseudoharengus*
American lobster	LOB	*Homarus americanus*
American shad	ASD	*Alosa sapidissima*
Atlantic herring	ATH	*Clupea harengus*
Black sea bass	BSB	*Centropristis striata*
Bluefish	BLF	*Pomatomus saltatrix*
Butterfish	BUT	*Peprilus triacanthus*
Cunner	CUN	*Tautogolabrus adspersus*
Fourbeard rockling	RCK	*Enchelyopus cimbrius*
Fourspot flounder	FSF	*Paralichthys oblongus*
Hogchoker	HOG	*Trinectes maculatus*
Little skate	LSK	*Raja erinacea*
Long-finned squid	SQI	*Loligo pealei*
Northern searobin	NSR	*Prionotus carolinus*
Red hake	RED	*Urophycis chuss*
Scup	PGY	*Stenotomus chrysops*
Silver hake	WHI	*Merluccius bilinearis*
Smooth dogfish	SMD	*Mustelus canis*
Striped searobin	SSR	*Prionotus evolans*
Summer flounder	SFL	*Paralichthys dentatus*
Tautog	BLK	*Tautoga onitis*
Weakfish	WKF	*Cynoscion regalis*
Windowpane flounder	WPF	*Scophthalmus aquosus*
Winter flounder	WFL	*Pseudopleuronectes*

FIGURE 2.1-1 LOCATION OF CONNECTICUT DEP TRAWL STATIONS AND DISPOSAL SITES

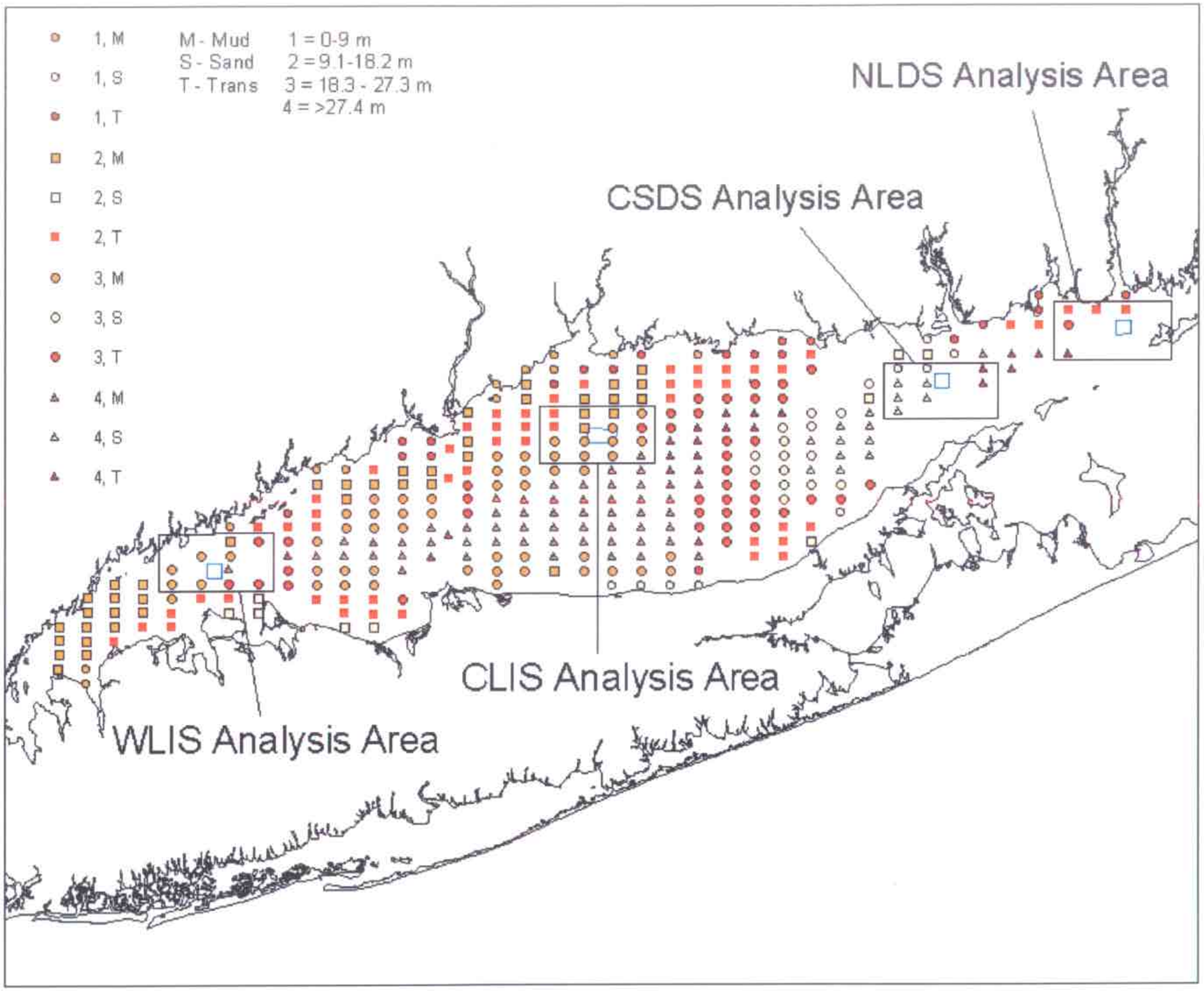
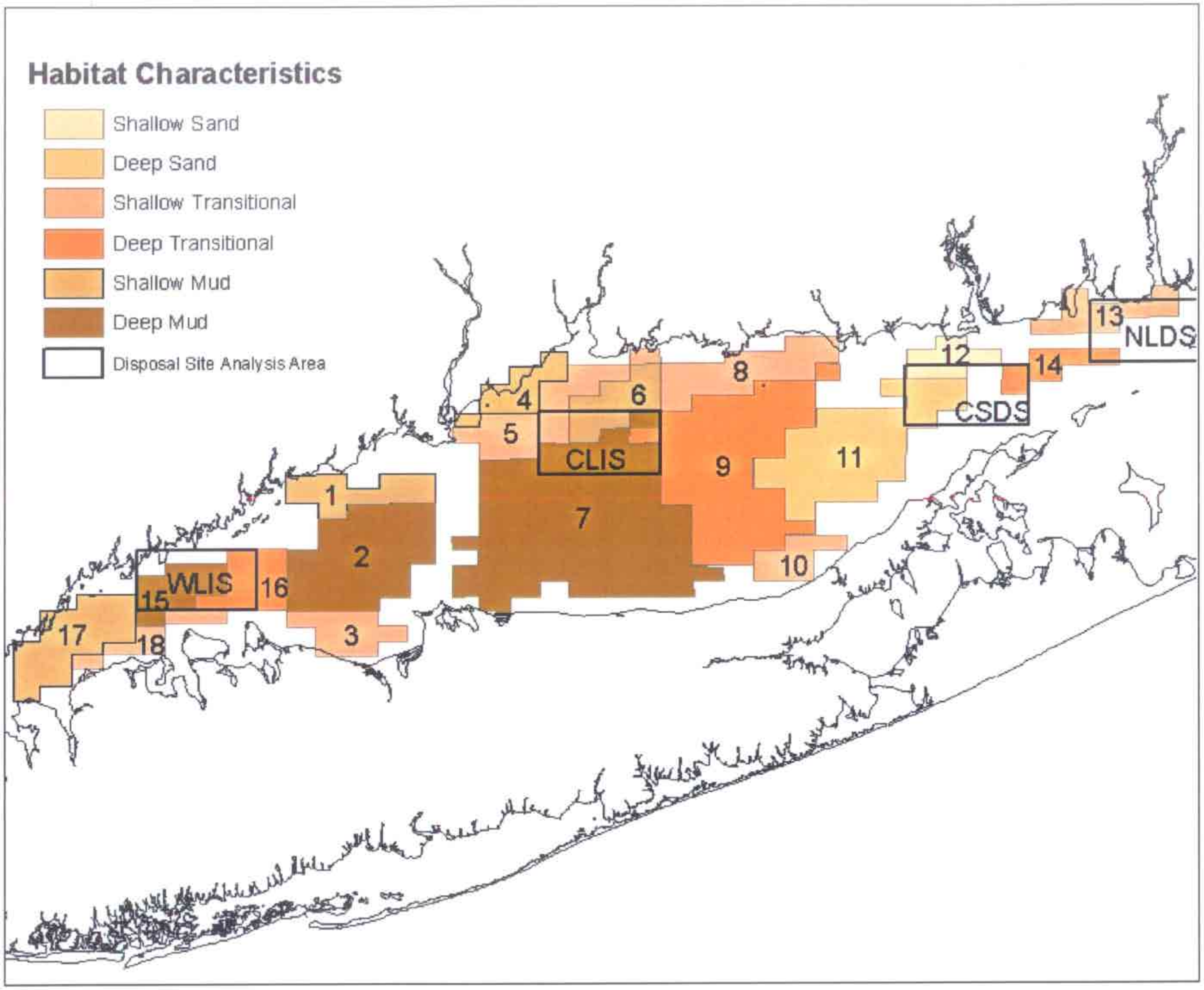


FIGURE 2.2-1 LOCATION OF HABITAT AREAS AND THEIR CHARACTERISTICS



3.0 RESULTS AND DISCUSSION

3.1 SPATIAL ANALYSIS OF FINFISH DISTRIBUTION

The general pattern of finfish abundance in LIS shows a marked increase in abundance in the Central and Western Basins in relation to abundance in the Eastern Basin (Figure 3.1-1). Specifically, the deep mud habitat areas and the adjacent transitional and shallow mud habitat areas of these basins contain stations with the highest average CPUE within LIS. Average CPUE within LIS ranged from 44.75 to 3171.63 individuals per tow over the survey period (1984-2000). Every station displayed on the map represents a location where fish were caught during the survey period.

The spring trawls yielded higher catches in the deeper areas of LIS (Figure 3.1-2), including the deep transitional area (habitat area 9) on the eastern end of the Western Basin. Nine stations had no catch (open circle) during spring because they were not sampled in spring (Figure 3.1-3). Catch abundance was low in the Eastern Basin with the exception of one station in the eastern end of the deep sand area (habitat area 11) and two stations in Niantic Bay (habitat area 13). The spring catch was also low to moderate in the far western end of LIS with the exception of two stations near Rye, NY.

The fall catch was generally higher at all stations than the spring catch and more closely matched the annual distribution (Figure 3.1-4). Seventeen stations had no catch (open circle) during fall because they were not sampled in fall during this survey (Figure 3.1-5). Catch abundance was particularly low in the Eastern Basin with the exception of one station in the deep sand area (habitat area 11). The fall catch was also low in shallow mud and transitional areas from New Haven to Hammonasset Point. In contrast to spring, several stations in the far western end of LIS had high CPUE in the fall. The highest fall catch came from areas in the Western Basin east of the Cable and Anchor Reef (habitat areas 1 through 3).

In general, the CPUE results from disposal site analysis areas were consistent with the results from the habitat areas selected for comparison (Figure 3.1-6). For example, the fall CPUE for CLIS disposal site analysis area was 1931 compared to 1853 for habitat area 7 (Table 3.1-1). In contrast, the fall CPUE for WLIS was less than half of the CPUE for Habitat Area 15, while the spring CPUE was nearly double that of habitat area 15. These results will be discussed in more detail below and with regard to individual species in Section 3.3.

Richness was far less variable between habitat areas and disposal site analysis areas than CPUE (Figure 3.1-7 and Table 3.1-2). As discussed by Gottschall et al. (2000) the eastern habitat areas (11, 12, 13, 14) had distinctly lower richness values than the Central and Western Basin habitat areas (1-10 and 15-18). In fact, location within LIS appeared to be a stronger determinant of richness than habitat area type. The habitat areas with the highest richness were located in the Central Basin surrounding the CLIS disposal analysis area (5,6,7,8,9,10). These habitat areas are a mix of shallow transitional, shallow mud, deep mud and deep transitional (Table 2.2-2). Shallow and deep mud habitat areas fringing the Central Basin (4) and within the Western Basin (1,2) also had relatively high richness with a distinct drop in richness in the spring. This drop in spring richness was also seen in other mud habitat areas (7, 15, 17) and in one shallow transitional area (8). Spring catch is dominated by winter flounder and many of these habitat areas had relatively low flounder catches (except habitat area 7, Figure 3.1-8). Two exceptions to these general patterns were habitat areas 14 and 16. Habitat area 16 had high richness in fall and spring, while habitat area 14 had a high richness for spring only. In particular, these deep transitional habitat areas had either moderately high catches of flounder (16) or little skate (14) in the spring and no dominant species in the fall. Richness values for disposal site analysis areas closely matched those for the closest habitat areas for both spring and fall (Table 3.1-2).

Because of the relatively small sample size of some of the habitat and disposal site analysis areas, and the potential for numerical dominance of small individuals of one species, it is useful to examine the distribution of the numerically dominant species by location. Spring tows were dominated by winter flounder, windowpane flounder and scup (Figure 3.1-8, note the secondary scale for Atlantic herring and Little skate). Butterfish, scup and bluefish dominated the fall catch (Figure 3.1-9, note the secondary scale for butterfish and weakfish). Specific results will be discussed below for each region of LIS.

3.1.1 Western Long Island Sound

Western Long Island Sound has been sparsely sampled by the CTDEP trawl survey due to the very high density of fixed lobster gear in this region of LIS prior to 2000 (Figures 3.1-3 and 3.1-5). In addition to the density of fixed gear, there are areas of rough or rocky bottom that make trawling on straight transects difficult. The catastrophic collapse of the Western LIS lobster fishery in 1999 spurred state agencies to increase efforts to evaluate the lobster resource and as a component of this effort, the CTDEP Fisheries Division added additional trawl stations in the far western Sound. While this is merely a snapshot of abundance and richness of finfish species in this area, it provides some indication of the resources that might be affected by disposal activities. It is also supported by the longer time series of stations adjacent to those added in 2000.

Western Long Island Sound has been divided into seven habitat areas and one disposal site analysis area for this report (Figure 3.1-10). In essence, there are two small basins separated by an area known as the Cable and Anchor Reef. Habitat area 2 is a deep mud area within the larger of these two basins and habitat area 15 is a deep mud area located with the smaller, more western basin. Habitat areas 1 and 17 are shallow mud areas that lie adjacent to mud areas with greater depth. Habitat areas 3 and 18 are shallow transitional areas along the Long Island shore. The WLIS disposal site analysis area contains all of the stations sampled from habitat area 15 and two additional stations from habitat area 16. Habitat area 16 is a deep transitional area that spans the Cable and Anchor Reef.

The Western Basin had high CPUE for both spring and fall. Habitat area 3 had the highest CPUE in the fall while habitat areas 1 and 2 ranked second and third, respectively (Figure 3.1-6 and Table 3.1-1). These high values were due to particularly high landings of scup in western LIS (Figure 3.1-9). All three areas had above average catches in spring sampling, mostly due to large collections of winter flounder and windowpane flounder (Figure 3.1-8). Westernmost areas of this basin had more patchy results. Although fall averages for habitat areas 15 through 18 were comparatively high, these results are based on a small number of tows in which one or two large catches can dominate the average (Figure 3.1-10 and Table 3.1-1). Limited sampling in this region complicates any comparison of CPUE with the WLIS disposal site analysis area. Only five trawlable stations were included in WLIS and these were trawled fifteen times in total. Of these, three stations constituted the entire sample for habitat area 15 (Figure 3.1-10). Spring catch at WLIS was the highest of any area while fall catch was below average. However, the similarity in patterns becomes clear when the distribution of dominant species is considered. WLIS was dominated by equivalent high catches of winter flounder and windowpane flounder with a smaller catch of scup in the spring of 2000 (Figure 3.1-8). This pattern is very similar to that found at habitat area 16 in the same year (with the scup coming from habitat area 15). In fall 2000, WLIS was dominated by a high catch of scup and weakfish, mirroring the results from habitat area 15 (with a component of butterfish from habitat area 16, Figure 3.1-9). Although these patterns are based on one year of sampling, there is clearly a relationship between the types of dominant species in these small groups of stations. Richness seems more stable in the WLIS area with values comparable to the surrounding habitat areas although lower in the fall than habitat areas 15 and 16 (Figure 3.1-7).

3.1.2 Central Long Island Sound

Central Long Island Sound represents the largest area of the Sound and is relatively unrestricted for research trawling. By far, the largest sample in this survey is from this region (Figure 3.1-11). Eight habitat areas and one disposal site analysis area (CLIS) are present in this region. Because of the large sample size, the disposal site analysis area was subdivided for comparison purposes into CLIS-(7) which contains stations from habitat area 7 and CLIS-(5,6,9) which contains stations from habitat areas 5, 6, and 9. This subsampling provides an opportunity to more closely evaluate potential impacts of disposal activities than is possible at the other disposal site analysis areas.

By far the largest area and sample set in this region is from the deep Central Basin (habitat areas 7, 9, and part of 11). These large habitat areas are in an unrestricted part of LIS and their large sample size provides a more robust comparison over time and space. The deep habitat areas shift from mud to transitional to sand along the west-east axis of the Sound (Figure 3.1-11). To the north, a series of nearshore shallow habitat areas shifts from mud to transitional to mud and back to transitional along the same axis. These habitat areas (4, 5, 6, 8) are more likely to be affected by nearshore, estuarine processes and the urban impact of New Haven Harbor. Habitat area 10 lies along the shallow transitional shoreline of Long Island near Mattituck.

Central Long Island Sound has high CPUE in nearshore habitat areas, with more moderate catches in the deeper basin and relatively low spring catches in the shallow transitional habitat areas (5, 8, 10). The shallow mud habitat area (6) just north of the CLIS disposal site, had the third highest fall CPUE in the survey (Table 3.1-1). This was due to high catches of butterfish and scup in this area (Figure 3.1-9). The deep mud habitat area (7) south of the disposal site also had high fall and spring catches due to butterfish and scup in the fall and winter flounder in the spring (Figure 3.1-8). Apart from an increased catch in the spring of winter flounder and windowpane flounder in habitat area 9, the CPUE for this basin decreased along the east-west axis over transitional and sand habitat areas (9 and 11). The high catches in habitat areas 5, 6 and 7 were actually clustered around and within the disposal site analysis area (Figure 3.1-11). This pattern contributed to a consistently high CPUE in all of the CLIS disposal site analysis area subsamples for spring and fall (CLIS, CLIS-(7), CLIS-(5,6,9)). The types of dominant species caught at CLIS were very consistent across subsamples and in comparison with adjacent habitat areas; spring trawls were dominated by winter flounder and windowpane flounder and fall trawls were dominated by butterfish and scup (Figures 3.1-8 and 3.1-9).

Richness was also quite high and stable in this region. Richness values dropped steadily from west to east, becoming lower in sandier habitats in fall. In spring, richness values dropped more sharply west to east from shallow nearshore areas (5, 6) to deep (7, 9, 11) and more eastern areas (8, 10) (Figure 3.1-7). The CLIS subsamples CLIS-(7) had a very close affinity in richness values with habitat area 7 for both seasons (Table 3.1-2). Based on the subsampling of these habitat areas it is impossible to distinguish the CPUE, richness or dominant species results of CLIS-(7) from the larger sample of habitat area 7 or the results of CLIS-(5,6,9) from the aggregate of habitat areas 5, 6, and 9.

3.1.3 Eastern Long Island Sound

Eastern Long Island Sound has been sampled intensively, yet within discrete patches, since trawling is limited by the irregular bottom and strong currents within this region. Much of the sampling effort has been directed to the nearshore areas of Connecticut (Figures 3.1-3 and 3.1-5). The region has been divided into four habitat areas and two disposal site analysis areas (CSDS and NLDS). Unfortunately, the sampling pattern does not provide extensive coverage of the disposal site analysis areas, thus limiting direct comparison of habitat areas with potential impacts of disposal activities. Nonetheless, the results do suggest some distinctive patterns of abundance and richness that may generally characterize this region.

Eastern Long Island Sound is characterized by deep sand and transitional habitat areas along the west-east axis and shallow sand and transitional habitat areas along the nearshore axis (Figure 3.1-12). Habitat area 12 encompasses Long Sand Shoal, an active region of seafloor at the mouth of the Connecticut River. The eastern portion of habitat area 11 meets the edge of Long Sand Shoal just north of the Cornfield Shoals Disposal Site (CSDS). This large deep sand habitat area covers a wide area but has shown consistent results from previous trawl survey analyses (Gottschall et al. 2000). The CSDS disposal site analysis area was skewed one mile to the south to reflect the deep nature of the site (more consistent with the characteristics of a deep sand habitat area). However, the analysis area does contain two stations from shallow sand and two from habitat area 14. Habitat area 14 is a narrow deep transitional area that just enters the NLDS disposal site analysis area to the east. It was necessary to include stations from habitat area 13 in the NLDS analysis area as there are no trawlable stations located near the disposal site. Habitat area 13 is a nearshore shallow transitional area dominated by stations in Niantic Bay.

All of the habitat areas in Eastern Long Island Sound had low CPUE (Figure 3.1-6). Habitat area 12 had the lowest CPUE for fall and spring of any of the sampled areas with an average of only 145 individual fish per tow (Table 3.1-1). Habitat areas 11, 13 and 14 were not far behind with average CPUE's of 494, 571, and 412 respectively. Fall catches were slightly higher, but the seasonal differences were less than for any other area. Habitat area 13 had the greatest increase in fall catch with a CPUE of 761; the spring catch was dominated by scup with the second highest average catch in LIS (Figure 3.1-8). Apart from this result and the little skate catch in area 14, the low catch totals for this region are due to a lack of catch of the dominant species (Figures 3.1-8, 3.1-9). Richness for these habitat areas was also the lowest of the survey indicating that eastern LIS supports low finfish abundance and low number of species (Figure 3.1-7). Habitat area 14 had relatively high richness in the spring and habitat area 13 had an increase in fall (Table 3.1-2).

The CSDS analysis area had a low CPUE comparable but slightly higher than habitat area 12. These results suggest that this area may be more reflective of the eastern end of habitat area 11 and habitat area 12 than had been assumed. It is difficult to ascribe this depressed CPUE to any disposal activity as the species richness of the area was comparable to habitat area 11 and disposal activity at this site has been very sporadic (USACE and USEPA 1998). CSDS may represent an area that is close enough to Long Sand Shoal and the influence of the Connecticut River to override any habitat area advantage conferred by deeper water.

It is difficult to make firm conclusions on the NLDS disposal site analysis area as most of the stations are far from the disposal site (Figure 3.1-12). The analysis area was skewed to the west to include as many stations as possible (none are sampled near Fisher's Island or Fisher's Island Sound). However, the set of stations nearest NLDS had a CPUE at or above that of habitat area 13 and a higher richness in both seasons. The comparatively large CPUE is due almost entirely to a large catch of scup in the spring, and relatively high catches of scup and butterfish in the fall at some of the NLDS stations (Figures 3.1-8, 3.1-9). At the very least these results, suggest that there is no discernable difference in the catch from stations near NLDS, apart from high catch of scup compared to stations further away.

The spatial distribution of CPUE, dominant species, and richness of finfish species within LIS and potential disposal sites has a complex pattern with seasonal variation. As a baseline characterization and tool for assessment of potential impact of disposal activities, the CTDEP data is more comprehensive and spatially detailed than any previous survey. While there are some limitations on characterizing specific areas of LIS, the detail available for CLIS provides a clear test of potential impact of disposal activities on long-term fish resources. It is never possible to account for all of the environmental variables that may influence spatial and temporal distribution of populations but if there were a strong gradient in impact (positive or negative) from these locations it should be apparent from the data associated with CLIS. This detailed spatial analysis failed to find any differences between stations near active disposal sites and comparable habitat areas near the disposal sites. This analysis will be discussed further in individual species distributions (Section 3.3).

3.2 SEASONAL PATTERNS

Although abundance as measured by CPUE has increased substantially during the survey period, all of the recent increase is in fall catch (Figure 3.2-1). Spring catch has remained remarkably even, between an average of 360 and 746 individuals per tow per year. In contrast, fall catch has increased over an order of magnitude from a low of 426 in 1987 to a high of 4296 in 1999. Species richness has also increased over the sampling period but both seasons have recorded gains (Figure 3.2-2). Spring richness increased from a low of 10.47 in 1987 to a high of 17.27 in 1999. Fall richness increased over the same years from 10.84 to 20.64.

Seasonal patterns of movement of commercial and recreational species in LIS have been described before (Richards 1963, Gottschall et al. 2000). Detailed discussion of spatial patterns has been related to habitat areas and disposal sites (see above) and will be further discussed below for individual species (Section 3.3). The temporal pattern of fish abundance (by season by year) has not been summarized and may provide some insight into potential impacts of disposal of dredged material on fish resources. Because the time period of the trawl survey overlaps completely with a period of episodic disposal of dredged material at four sites in LIS, these spatial and temporal patterns have relevance to assessment of potential future impacts.

Spring months in LIS are characterized by warming water temperatures and migration of finfish species into the Sound. Demersal species generally dominate all habitat areas at this time and are particularly abundant on mud habitat areas in April and May (Gottschall et al. 2000). The top six finfish species in CPUE in spring include four demersal species (winter flounder, scup, windowpane flounder, and little skate) and two pelagic species (atlantic herring and silver hake). In addition, two invertebrate species, the American lobster and long-finned squid contribute to noticeable amounts to the total CPUE. Most of the variation in average spring CPUE over the survey period can be accounted for by variations in abundance of winter flounder, scup and windowpane flounder (Figure 3.2-3). Both winter flounder and windowpane flounder have declined in abundance since 1990 with increases in scup and lobster helping to keep average CPUE fairly steady (compare Figures 3.2-1 and 3.2-3).

Fall months in LIS are characterized by cooling water temperatures and migration of many species out of the Sound. Overall, catch is much higher and dominated by pelagic species that are caught more frequently on mud and transitional habitat areas than sand (Gottschall et al. 2000). The top five finfish species in CPUE in fall include three pelagic species (butterfish, bluefish, and weakfish) and two demersal species (scup and windowpane flounder). In addition the two common invertebrate species, American lobster and long-finned squid provide as much as one-fifth of the average CPUE in some years. The steady increase in fall CPUE since 1987 can be accounted for by large increases in the catch of butterfish and more recently scup and weakfish (Figure 3.2-4). Windowpane flounder have declined in abundance since 1989 leaving scup as the only demersal species caught in large numbers in fall trawls.

3.3 SPECIES DISTRIBUTIONS

Alewife (*Alosa pseudoharengus*)

The relative abundance of alewives was higher between 1992 and 2000 compared to their abundance between 1984 and 1991 (Figure 3.3-1). Average CPUE for alewives ranged from a low of 0.13 fish/tow in the fall of 1985 to a high of 15.3 fish/tow in the spring of 1999. Overall, the relative abundance of alewives was higher in the spring than in the fall. The highest catches of alewives during the study period occurred in the spring in 1994, 1996, and 1999. The fewest number of fish were collected in the fall of 1985, 1989, and 1991.

Alewives were broadly distributed in LIS during both seasons (Figure 3.3-2). In spring, alewives were captured in all habitats and disposal areas but were observed most frequently along the shoreline of the Western and Central Basins in shallow habitats containing mud and transitional sediments. The greatest concentration of alewives captured in the spring was collected from Habitat 1 (10.3 fish/tow), Habitat 4 (19 fish/tow), Habitat 6 (8 fish/tow), and Habitat 8 (9 fish/tow). In the fall, alewives were more abundant in the Central Basin and the eastern end of LIS. Average CPUE was highest within CLIS-(7) (10 fish/tow), Habitat 12 (6.5 fish/tow), and NLDS (16.5 fish/tow). CLIS-(7) is a deep, mud habitat while Habitat 12 and NLDS are shallow sand and shallow transitional habitats, respectively. Habitat 12 and NLDS border the mouths of the Connecticut and Thames rivers. Alewives were rarely collected in the western end of LIS or in deep habitats in the fall.

The relative abundance of alewives varied among the four disposal site analysis areas. Highest abundance occurred within NLDS in the fall (mean of 16.5 fish/tow). The average CPUE of alewives at the comparison habitats for NLDS was much lower than within NLDS. Three alewives were collected per tow at site 13 in the fall and only one fish per tow was found at this site in the spring. Similarly, at site 14, no alewives were taken in the fall and an average CPUE of one fish per tow was found in the spring. Alewives were not collected from either CSDS or WLIS in the fall and were found at these areas in low abundance in the spring (1.3 fish/tow and 2.1 fish/tow, respectively). Average catches of alewives at sites 11, 15, and 16, the comparison habitats for CSDS and WLIS, were comparable to the catch levels at CSDS and WLIS. Alewife CPUE showed little variation between seasons at CLIS, though average CPUE at CLIS-(7) was slightly higher in the fall. More alewives were collected within CLIS-(7) than at the comparison site, Habitat 7.

American Lobster (*Homarus americanus*)

The average CPUE for lobsters in the trawl survey increased slightly during the 1990s (Figure 3.3-3). An unusually high number of lobsters were collected in the fall of 1997 (mean of 139 lobsters/tow) while the lowest catches occurred in the spring of 1986 (mean of 9 lobsters/tow). In all but three years (1984, 1998, and 1999), the CPUE for lobsters was higher in the fall than spring.

Lobsters were unevenly distributed within LIS (Figure 3.3-4). The highest numbers of lobsters were collected in the western end of the Sound, mostly within deep regions containing either mud or transitional sediments. The highest average CPUE for lobsters (162 lobsters/tow), however, occurred in Habitat 1, a shallow muddy region within the Western Basin. Lobsters were also common in deep mud and deep transitional areas of the Central Basin. Few lobsters were collected from sandy habitats within the Central and Eastern Basins. Although catches of lobsters tended to be higher in the fall, there was no difference in the spatial trend of lobster collections between spring and fall.

Lobsters were relatively more abundant within the WLIS and CLIS disposal site analysis areas than in the NLDS and CSDS. Average CPUE of lobsters was comparable between these disposal site analysis areas and their comparison habitats. At WLIS, NLDS, and CSDS, lobster abundance was consistent between spring and fall. In contrast, mean CPUE of lobsters at CLIS was higher in the fall than in the spring. At sites 15 and 16, the comparison habitats for WLIS, relatively more lobsters were collected in fall versus spring tows. Among the analysis areas the greatest number of lobsters were collected from CLIS-(5,6,9) (137 lobsters/ tow) while the fewest number of lobsters were found within CSDS (mean of 1 lobster/tow).

The lobster results do not reflect the dramatic decline of lobster landings in western Long Island Sound in 1999. Average fall lobster CPUE did decline from the peak in 1997, but this peak was almost entirely due to exceptionally high 1997 CPUE from habitats 1 and 2 in the western basin and habitat 6 in the central basin. The trawl data generally reflects a different catch than pot landings (i.e., trawl may catch high numbers on level bottom when lobsters won't "pot" or the trawl may be unable to catch efficiently on uneven bottom), but several habitat results are notable. The only habitat with significant decline in 2000 was habitat 2 which declined from a spring CPUE peak of 454 in 1999 to 198 in 2000 (fall catch declined from 207 to 75). Habitat 1 had low fall CPUE in 1998 (50), but the catch rebounded in 1999 and 2000 to about one half of levels seen prior to 1998 (120). The fall CPUE of habitats 3, 4, and 7 also fell in 2000 but apart from 7, these habitat areas have low trawl CPUEs. Habitats 17 and 18 in the far western Sound had very low catch, while WLIS and habitats 15 and 16 had high catches but none of these habitats had results from 2000 that represented a drop in CPUE. These areas were not sampled extensively prior to 2000, but apart from 15 these areas do include some data from previous years.

American shad (*Alosa sapidissima*)

Catches of American shad in the trawl survey cycled regularly between high and low numbers throughout the study period (Figure 3.3-5). Shad abundance peaked in 1984, 1988-1989, 1993, and 1999. The average CPUE during the study period ranged from a high of 30 fish per tow in 1993 to a low of 1 fish per tow in 1985. Shad were relatively more abundant during the fall than in the spring.

American shad were broadly distributed in LIS during both spring and fall (Figure 3.3-6). Higher catches of shad occurred in the Central Basin (Habitats 4-6, 8), in the Narrows (Habitat 17), and within the NLDS area. American shad were primarily collected in shallow mud and shallow transitional habitats along the Connecticut shoreline and were relatively less abundant in deeper regions of the Sound. In general the spatial distribution of shad did not vary greatly between seasons, although more shad were collected within shallow transitional habitats (Habitats 3 and 18) along the shore of Long Island in the spring.

Higher numbers of American shad were collected from the CLIS and NLDS disposal analysis areas than from CSDS and WLIS. An average of 16 shad were collected per tow at CLIS while less than one shad per tow was collected from either CSDS or WLIS. Mean CPUE was greater in the fall at CLIS and NLDS while there was a slightly higher mean catch of shad in the spring at CSDS and WLIS. In general, average catches of shad at CLIS and NLDS were comparable to average catches at the comparison habitats for these sites. The average number of shad collected at site 7 in the fall, however, was three times lower than the mean number captured at CLIS-7. During the fall, more shad were collected from sites 11 and 16, the comparison habitats for CSDS and WLIS, than at the CSDS and WLIS analysis areas. In the spring, low numbers of shad were captured at both analysis areas and comparison sites.

Atlantic herring (*Clupea harengus*)

The relative abundance of Atlantic herring, similar to American shad, followed a repetitive high-low pattern throughout the study period (Figure 3.3-7). Periods of higher abundance in the trawl survey were the spring of 1985 (39 fish/tow), 1990 (83 fish/tow), 1995 (68 fish/tow), and 1999 (50 fish/tow). Spring sampling yielded much higher catches of Atlantic herring than the fall sampling.

Atlantic herring were widely distributed in LIS during both spring and fall (Figure 3.3-8). They occurred in nearly all habitat types and throughout most regions of the Sound. Highest catches of Atlantic herring occurred within shallow habitats along both the Connecticut and New York shoreline in the Central and Western Basins. Atlantic herring were also highly abundant in Habitat 16, a deep transitional area within the Western Basin. The lowest catches of Atlantic herring occurred in the Eastern Basin.

Atlantic herring were collected at stations sampled within each of the disposal analysis areas. The greatest number of Atlantic herring was found during the spring within CLIS-(5,6,9) (42 fish/tow), followed by NLDS (13 fish/tow). Only a very small number of fish were collected from CSDS and WLIS during spring sampling and no herring were collected from these areas in the fall. Average CPUE of herring at CLIS, CSDS, and NLDS was similar to average CPUE of herring at the comparison habitats for these sites. In contrast, an average of 109 herring were collected at habitat 16 as compared to an average of less than one fish per tow taken from WLIS.

Black Sea Bass (*Centropristis striata*)

The abundance of black sea bass in the trawl survey was very low (Figure 3.3-9). Average CPUE during the study period ranged from 0 to 1.2 fish per tow. Although they constituted a small percentage of the catch, black sea bass were collected from most habitats and within three of the four disposal areas within the Sound. Black sea bass were not found in Habitats 15 and 18 or the WLIS disposal site analysis area. In the fall, black sea bass were relatively more common in shallow habitats between the Housatonic River and New Haven Harbor, Habitat 16 (a deep, transitional area), and within the NLDS analysis area. The spring distribution of black sea bass was similar to the fall distribution except that black sea bass were relatively more abundant in the CLIS disposal area. Due to the low abundance of black sea bass in the survey, it is difficult to draw meaningful comparisons between the relative abundance at disposal area analysis sites and comparison habitats.

Bluefish (*Pomatomus saltatrix*)

The abundance of bluefish varied cyclically during the study period (Figure 3.3-11). Bluefish have become relatively more abundant in recent years. Although they rarely occur in the Sound during the spring, bluefish are among the most dominant species collected in fall sampling.

Bluefish are commonly found along Stratford Shoal in the Western and Central Basins and within the Narrows of the Western Basin. A pelagic predator, bluefish have been found in all habitat areas of the Sound (Figure 3.3-12). The largest catches of bluefish occurred in Habitat 3, a shallow transitional region near Smithtown Bay off Long Island. Bluefish were caught in small numbers in the Eastern Basin.

The relative abundance of bluefish captured during the fall varied among the four disposal areas. Relatively high catches of bluefish occurred within the CLIS-(5,6,9) disposal area (128 fish/tow) while much smaller numbers of bluefish were collected at CSDS (4 fish/tow), NLDS (7 fish/tow), and WLIS (9.5 fish/tow). The mean CPUE of bluefish at the comparison habitats for CSDS and WLIS was slightly higher than the mean CPUE of bluefish at CSDS and WLIS. Average CPUE of bluefish at CLIS-7, CLIS-5,6,9 and NLDS was nearly identical to the average CPUE of bluefish found in surrounding habitat areas with similar characteristics.

Butterfish (*Peprilus triacanthus*)

Butterfish abundance grew steadily from 1984 to 1999 and then dipped in 2000 (Figure 3.3-13). At their peak abundance level in 1998 and 1999 an average of nearly 2000 butterfish were captured per tow. Butterfish are collected mainly in the fall. A significantly lower number of individuals are taken in the Sound during the spring.

Butterfish occur in nearly all habitats of LIS (Figure 3.3-14). Most butterfish were found in habitats bordering Stratford Shoal in the Western and Central Basins and within the CLIS disposal area. Regions of butterfish occurrence include deep and shallow mud habitats and shallow transitional areas. Relatively lower catches of butterfish occurred near the eastern end of LIS. The CSDS had the smallest average CPUE for butterfish among the disposal areas (61 fish per tow). The abundance of butterfish at the WLIS disposal area (192 fish/tow) was comparatively higher than butterfish abundance in Habitat 15 (42 fish/tow) but substantially lower than the average abundance of butterfish at habitat 16 (701 fish per tow). Habitat 15 is primarily a muddy habitat while Habitat 16 contains transitional sediments.

Cunner (*Tautogolabrus adspersus*)

Mean CPUE for cunner dropped from a high of 24 fish per tow in spring of 1984 to a low of 0.3 fish per tow in the spring of 1995 (Figure 3.3-15). The relative abundance of cunner remains low. Few captures of the species occur in the fall.

Cunner exhibit a discrete distribution in the Sound (Figure 3.3-16). Most captures occur in the Western Basin, within WLIS and Habitats 16 and 18. These regions contain shallow mud and deep transitional stations. Cunner were also found in higher abundance in Habitat 6, a shallow mud region near New Haven Harbor.

Among the disposal areas, cunner were most abundant within WLIS and CLIS-(5,6,9). The highest average catch of cunner in the survey occurred in the spring at WLIS (30 cunner/tow) while few fish were found at CSDS (0.5 fish/tow) and NLDS (1.2 fish/tow). Few fish were also found at the comparison habitats fro CSDS and NLDS. Cunner were much more common in the WLIS disposal area than in Habitat 15 (less than one fish per tow), the primary habitat of comparison for this area. Conversely, the relative abundance of cunner at CLIS-(5,6,9) (5 fish/ tow) was roughly equivalent to the abundance of cunner at Habitat 6 (8 fish/ tow).

Fourbeard Rockling (*Enchelyopus cimbrius*)

Rockling abundance in the trawl survey dropped from a high, in 1984, of 11 fish per tow to 1.9 fish per tow in 2000 (Figure 3.3-17). More rockling were collected in the Sound in the spring than in the fall. Despite variable seasonal abundance, the seasonal distribution of fourbeard rockling was similar: most fish were collected in the WLIS disposal area and within deep mud (Habitat 2) and deep transitional regions (Habitat 16) of the Western Basin (Figure 3.3-18).

Higher numbers of rockling also occurred in Habitats 5-7 and within CLIS-(5,6,9). These areas contain mud and transitional sediments and have both deep and shallow regions. Rockling were not collected in the Eastern Basin, including the CSDS and NLDS disposal areas, and few fish were taken in shallow habitats within other reaches of the Sound. The average catch of rockling at the WLIS disposal area in the spring (12 fish per tow) was greater than the average CPUE in Habitat 15 (3 fish per tow) but nearly the same as the average catch of rockling in Habitat 16 (10 fish per tow). Slightly more rockling were collected in the spring in CLIS-5,6,9 than within the comparison habitats for this site while the average catch of rockling was similar between CLIS-7 and Habitat 7.

Fourspot flounder (*Paralichthys oblongus*)

The highest abundance of fourspot flounder during the survey occurred in the spring of 1984 (Figure 3.3-19). After this period, abundance dropped but has remained fairly steady in recent years. Fourspot flounders show greatest abundance in the spring. This species is encountered over all bottom types and at all different depths within the Sound. The relative abundance of fourspot flounders is greatest in the Western and Central Basins in deep habitats (Habitats 2, 7, and 16) containing mud and transitional sediments (Figure 3.3-20). The lowest abundance of fourspot flounders occurs in the Eastern Basin.

In spring, fourspot flounders had relatively high abundance at WLIS (43 fish/tow) and CLIS-(7) (27 fish/tow) in contrast to reduced abundance at the CSDS disposal area (9 fish/tow) and NLDS (< 1 fish/tow). The mean CPUE for fourspot flounders was comparable between WLIS and Habitat 16 and between CLIS-(5,6,9) and CLIS-(7), indicating similar distribution of the species inside and outside of these disposal areas. Similarly, the mean CPUE for fourspot flounders showed little variation between the catch reported within the CSDS and NLDS disposal areas and the surrounding habitats.

Hogchoker (*Trinectes maculatus*)

The abundance of hogchokers in the trawl survey was very low (Figure 3.3-21). The highest average CPUE, which occurred in the spring of 1993, was three fish per tow. There was only a slight variation in the distribution of hogchokers in LIS between seasons.

Hogchokers were broadly dispersed in LIS and were found within all habitat types (Figure 3.3-22), though they were slightly more abundant within Habitat 16 and shallow and deep transitional habitats within the Central Basin. Hogchokers were not collected from Habitat 18 or from the easternmost habitats of Sound, including the NLDS disposal site analysis area.

An average of one hogchoker per tow was collected within the CSDS, CLIS, and WLIS disposal area analysis areas. Hogchoker abundance within the primary comparison habitats closely matched abundance at disposal site analysis areas. The relative abundance of hogchokers within Habitat 16 was slightly higher, in both seasons, than in WLIS.

Little skate (*Raja erinacea*)

Little skate were moderately abundant during the trawl survey. The average abundance for little skate hovers around 20 fish per tow for most survey years except for a brief period in the early 1990s when mean CPUE for little skate exceeded 40 fish per tow (Figure 3.3-23). There was little variation in the seasonal abundance of little skate, although spring catches tend to be higher than fall collections.

Little skate were narrowly distributed in LIS (Figure 3.3-24). Highest skate abundance occurred within sand and transitional habitats along the Mattituck Sill and Eastern Basin. Little skate were collected at all depths within this region. Habitat 14 supported the greatest number of skate in both seasons; an average of 108 skate per tow were found here in the fall and, in the spring, a mean catch of 71 skate per tow was obtained. Little skate were rarely collected in the Western Basin and were not very abundant in the Central Basin. Most of the skate collected in the Central Basin were found in shallow, shoreline habitats containing transitional bottom types. On average, 12 fish were collected in tows within the Central Basin.

Little skate were not very abundant at any of the disposal analysis areas except for CSDS. An average of 59 skate were captured per tow within this area as compared to a mean of less than 11 fish per tow found at any of the other disposal areas. Little skate were relatively more abundant at CSDS than at Habitat 11, the primary comparison habitat for this area.

Long-finned squid (*Loligo pealei*)

Long-finned squid were among the most abundant species collected during fall sampling. Squid were relatively less abundant in the spring (mean of less than 100 squid per tow), although their numbers during this season remained almost constant throughout the study period. In the fall of 1993, mean squid abundance peaked at 500 individuals per tow. In most years, the abundance of squid in the fall averaged approximately 200 individuals per tow.

Long-finned squid were broadly distributed in the Sound during the fall. Squid were most abundant in mud and transitional habitats at depths greater than 18 meters. Habitat 16 yielded the largest number of long-finned squid (mean of 644 individuals/tow) while Habitat 12 contained the fewest amount of squid (mean of 50 squid/tow). In spring, before squid became abundant in the Sound, most individuals were collected in the Eastern Basin.

The seasonal distribution of long-finned squid among the disposal areas reflected their Sound-wide distribution pattern in each season. In spring, the NLDS analysis area supported the highest number of long-finned squid (106 squid per tow). Unlike all of the other disposal areas, squid abundance at NLDS varied only slightly between seasons. A nearly equivalent amount of squid was also found at Habitat 13, the primary comparison habitat for NLDS. In the fall, when squid abundance increased in the Central and Western Basins, the portion of the CLIS disposal area within Habitat 7 contained the greatest number of squid (258 squid per tow). The abundance of squid within Habitat 7 in fall sampling (358 squid per tow) was greater than squid abundance in CLIS-7. During spring sampling, average CPUE of squid at these sites was comparable. The average abundance of squid at WLIS was identical to the average abundance of squid at Habitat 15. Long-finned squid were slightly more abundant at Habitat 11 than at

CSDS during the fall while, in the spring, the average CPUE of squid at these areas was approximately the same.

Northern searobin (*Prionotus carolinus*)

Northern searobin were not very abundant in the trawl survey. The highest abundance for this species occurred in 1985 when an average of 26 fish were collected in spring sampling. Since then, searobin catches have decreased, averaging fewer than 10 fish per tow in each season (Figure 3.3-27). Northern searobins are slightly more abundant in the Sound in the spring.

In spring, the season of highest northern searobin abundance, searobin were captured in all habitats of LIS. They were most abundant along Mattituck Sill in sand and transitional areas of varying depths. Northern searobin were also collected in relatively higher numbers in deep reaches of the Western Basin containing mud and transitional sediments. The abundance of northern searobin decreased with depth in the spring. In contrast, northern searobin were relatively more abundant in shallow habitats in the fall. Northern searobin were relatively more abundant in both deep and shallow transitional habitats in the Eastern Basin in the fall compared to spring.

Northern searobin abundance varied seasonally among the disposal site analysis areas. The relative distribution of northern searobin in the analysis areas closely resembled their general distribution in the Sound. In the spring, northern searobin were most abundant in the WLIS and CSDS analysis areas, (mean of 11 fish/tow and 6 fish/tow, respectively) while the NLDS analysis area contained the greatest abundance of northern searobin in the fall (mean of 5 fish/ tow). The CLIS analysis area yielded the smallest abundance of northern searobin in fall sampling and the second to lowest abundance of searobin, next to NLDS, in spring sampling.

Red hake (*Urphycis chuss*)

Red hake were variably abundant in LIS during the 16-year study period. In several years - 1984, 1989 and 1993 – mean CPUE exceeded 30 red hake per tow. In most years, however, CPUE for red hake averages less than 25 fish per tow. Red hake are more dominant in the Sound in the spring. Relative abundance in the fall averages fewer than five fish per tow.

Red hake were widely distributed in the Sound in both seasons. Although relative abundance varied season-to-season, red hake were distributed similarly in spring and fall. Red hake predominate in deep regions of the Central and Western Basin with mud and transitional bottoms. Red hake are least abundant in shallow habitats and within the Eastern Basin.

Like their Sound-wide distribution, red hake were most abundant in disposal site analysis areas containing mud and transitional bottoms: CLIS and WLIS. Mean abundance of red hake at the CSDS and NLDS disposal areas ranked third and fourth respectively. Slightly more red hake were found at Habitat 7 than CLIS-7. Average abundance of red hake CLIS–5,6,9 was higher than the average catch at Habitats 5 and 6 (shallow regions) but lower than the average catch of red hake at Habitat 9 (a deeper region). Red hake had similar abundance at WLIS and within its surrounding Habitats, 15 and 16. Red hake were rarely captured at NLDS but were relatively more common in Habitats 13 and 14.

Scup (*Stenotomus chrysops*)

Scup were very abundant in the trawl survey. Like many species collected from the Sound, scup show strong seasonal variation; fall catches of scup greatly exceed spring captures. In recent years, scup abundance has increased dramatically (Figure 3.3-31). Mean CPUE in 1999 and 2000 was 1294 and 834 fish per tow, respectively. These levels of abundance represent a four to six-fold increase in average abundance for scup over the number of fish collected during most years of the survey.

Scup were found in all habitats and within each of the Sound's three major basins during both seasons (Figure 3.3-32). Scup were most abundant, in the fall, within the Western Basin. In particular, the area with the highest average abundance for scup was Habitat 3, a shallow transitional region that encompasses Smithtown Bay. An average of 773 scup were collected in trawl samples within this habitat. The areas with the next highest scup abundance were shallow regions of the Central Basin containing mud and transitional sediments along both the Connecticut and New York shorelines. The areas yielding the lowest catches of scup in the fall were sandy habitats in the Eastern Basin and Habitat 8, a shallow transitional region between the Quinnipiac and Hammonasset Rivers. The distribution of scup in spring sampling varied somewhat from fall sampling. Although scup were found in relatively high abundance in shallow transitional regions of the Western Basin, they were also commonly taken in a shallow transitional habitat within the Eastern Basin.

The LIS disposal analysis areas with greatest scup abundance were WLIS (mean of 491 fish/tow) and NLDS (mean of 388 fish/tow). Within Habitat 15, the primary comparison area for WLIS, mean scup abundance was 448 fish/tow. An average of 286 scup were captured in trawl samples from Habitat 13, the primary comparison area for NLDS. Nearly identical numbers of scup were taken at CLIS analysis areas and its primary comparison areas. Scup were relatively scarce at the CSDS analysis area and, in the fall, were collected in higher numbers at Habitat 11, the primary comparison site for this analysis area. Scup were moderately abundant within the CLIS analysis area (mean of 283 fish per tow) and were collected in comparable numbers within Habitats 5, 6, 7,and 9.

Silver hake (*Merluccius bilinearis*)

Silver hake were moderately abundant in LIS during survey years (Figure 3.3-33). The highest and lowest CPUE for silver hake were obtained in the most recent years if sampling. In 1999, a mean high of 53 fish per tow were collected whereas only 4.6 silver hake were taken per tow in 2000. In all but one of the study years, silver hake were more abundant in spring samples versus fall samples.

Silver hake exhibit a patchy distribution in LIS (Figure 3.3-34). The general distribution of silver hake in the Sound did not vary from season to season. Highest catches for the species occur within the CLIS disposal site analysis area and along Stratford Shoal in the Western and Central Basins. This region consists of shallow and deep stations with mud bottoms. The regions with the next highest abundance were transitional areas of the Central and Western Basins. Silver hake were least abundant at the western end of the Sound and within shallow shoreline habitat in the eastern end of the Sound.

Among the four disposal areas, the relative abundance of silver hake was highest at CLIS-(5,6,9) (mean of 30 fish per tow) and lowest at NLDS (1 fish per tow). Silver hake abundance within the disposal analysis areas closely corresponded to their relative abundance in the Sound. In addition, mean numbers of fish at the analysis areas were similar to average CPUE of silver hake at comparison habitats.

Smooth dogfish (*Mustelus canis*)

The abundance of smooth dogfish in LIS was relatively low during the study period (Figure 3.3-35). The highest average catches, which occurred in 1984 and 1998, were 6.4 and 7.5 dogfish per tow, respectively. In general, fall collections of smooth dogfish were greater than the numbers of dogfish captured in spring.

Smooth dogfish were widely distributed in the Sound although regions of greatest abundance varied between seasons (Figure 3.3-36). In the fall, highest CPUE for smooth dogfish occurred in deep regions of the Eastern Basin containing sand and transitional sediments. Average CPUE for dogfish was greatest in the CSDS (9.1 fish/ tow) followed by an average catch of eight fish per tow in Habitat 14. Shallow mud and deep transitional areas within the Western and Central Basins also had relatively high mean catches of dogfish. CLIS-7, a deep mud site within the Central Basin, yielded slightly higher catches of dogfish in the fall than any of the other habitats within CLIS. During spring sampling, dogfish abundance was roughly equivalent within the CLIS analysis area. Habitat 5, a shallow mud region, had the highest average CPUE of dogfish in spring sampling within the Central Basin, exceeding the average catch within CLIS 5,6,9. Smooth dogfish were not found within the WLIS analysis area in the fall or within adjoining Habitat 15. Conversely, an average of 5 fish were collected per tow in Habitat 16 during the fall. In the spring, smooth dogfish were taken in higher numbers within the WLIS analysis area and comparable habitats in the Western Basin. Smooth dogfish were also common in the spring in shallow transitional habitats in the Western and Central Basins. No dogfish were collected during the spring at the NLDS analysis area or adjoining Habitat 13.

Striped searobin (*Prionotus evolans*)

Striped searobin were moderately abundant in the trawl survey (Figure 3.3-37). The average CPUE of striped searobin has increased in recent years. In general, striped searobin are more common in the Sound in the fall yet the highest average CPUE for striped searobin occurred in spring sampling in 2000.

Striped searobin were taken in all areas of the Sound but were most abundant, in both spring and fall, in the WLIS and adjacent Habitat 15 (mean, at both areas, was 45 fish/tow). Regions of next highest abundance for this species were shallow mud habitats in the Western and Central Basins. Striped searobin were least abundant in sandy habitats and within the Eastern Basin. Striped searobin were not captured in high numbers at any of the disposal analysis areas except for WLIS.

Summer flounder (*Paralichthys dentatus*)

Summer flounder abundance in the Sound has increased in recent years (Figure 3.3-39). Summer flounder are a moderately abundant species in the LIS; highest mean catches were between 59 and 75 fish per tow. Relatively more summer flounder are captured in the Sound in the fall than in spring, however spring abundance of summer flounder has been steadily increasing since 1995.

Summer flounder were evenly distributed in LIS during both sampling seasons (Figure 3.3-40). Average catches in most habitats and analysis areas were less than three fish per tow. Slightly more flounders were collected in shallow mud and transitional areas of the Western and Central Basins during the fall. In spring, the highest mean abundance for summer flounders was found in Habitat 17 (5 fish per tow), a shallow mud area in the western end of the Sound. The abundance of summer flounder in the disposal area analysis areas closely matched the average abundance of summer flounder in comparison habitats.

Tautog (*Tautoga onitis*)

Tautog abundance was low for all years of the survey (Figure 3.3-41). Average CPUE for this species has declined since the first year of the survey and remained at consistently low numbers for the past 15 years. Average abundance for tautog is higher in the spring although, in recent years, this seasonal difference is minimal.

Tautog occur in all habitats in the Sound in both seasons. In the spring, relatively more fish are collected in shallow habitats in the Western and Central Basins where mud and transitional sediments dominate.

Highest catches of tautog in the fall occur in transitional areas within the Western Basin, with shallow mud habitats in the Central Basin constituting regions of next highest abundance during this season.

Tautog were relatively uncommon at all of the disposal areas. Highest average catches, occurring in the spring, were 5 fish per tow (CLIS-5,6,9) and four fish per tow (WLIS). Few tautog were collected in the CSDS and CLIS-7 areas. The relative abundance of tautog at disposal site analysis areas was slightly higher than in their comparison habitats, yet overall catch levels were very low (Figure 3.3-42).

Weakfish (*Cynoscion regalis*)

Weakfish were moderately to highly abundant in the trawl survey (Figure 3.3-43). Weakfish mainly occur in LIS in the fall. Few spring captures have been recorded since the survey began. The highest mean catch of weakfish occurred in 2000 when more than 460 fish were collected per tow.

Weakfish have a patchy distribution in the Sound (Figure 3.3-44). Average catches of weakfish are highest in deep mud habitats within the Western Basin. An average of 1159 weakfish were collected per tow within Habitat 15. Relatively high numbers of weakfish were also been collected from shallow reaches of the Western Basin, in areas containing both mud and transitional sediment. Mean abundance at Habitat 18 was 646 fish per tow and average abundance at Habitat 17 was 322 fish per tow. Weakfish are rarely encountered in the Eastern Basin. Other than WLIS, where an average of 580 weakfish were collected per tow, weakfish were not very abundant at any of the disposal areas. Mean catches of weakfish at CLIS, CSDS, and NLDS analysis areas were similar to average numbers of weakfish found within comparison habitats while twice as many weakfish were collected from Habitat 15 than within WLIS.

Windowpane flounder (*Scopthalmus aquosus*)

The spring abundance of windowpane flounder abundance has decreased considerably since the trawl survey began in 1984 (Figure 3.3-45). In the spring of 1984 an average of 314 fish were collected per tow, while in the spring of 2000 only 23 fish were captured per tow. The fall abundance of windowpane flounder has remained consistent but low over the course of the survey.

Windowpane flounder are broadly distributed in most regions of LIS in both seasons (Figure 3.3-46). Regions of highest mean abundance are deep habitats within the Central and Western Basins containing mud and transitional sediment. Relatively few windowpane flounder are collected in the eastern end of the Sound. Windowpane flounder were most abundant within WLIS and CLIS disposal sites. More flounders were captured within Habitat 16 (215 fish per tow) than in WLIS (155 fish per tow). Habitat 9 yielded the highest number of flounders within the Central Basin and was higher than the average number of flounders taken in CLIS-5,6,9. More than three times as many windowpane flounder were collected, on average, from Habitat 11 than the CSDS during spring sampling. Very few flounders were collected from habitats within the eastern en d of LIS, including NLDS.

Winter flounder (*Pseudopleuronectes americanus*)

Winter flounder were highly abundant in the trawl survey from 1984 to 1991; in most of these years, average catches were greater than 100 fish per tow. Since 1992 the relative abundance of winter flounder abundance has dropped. In 2000, the year with the lowest mean catch for winter flounder, sampling averaged 46 fish per tow (Figure 3.3-47). Winter flounder are significantly more abundant in spring versus fall samples.

Winter flounder are broadly distributed in the Sound. Relatively high catches of winter flounder occur in deep regions of the Central and Western Basins (Figure 3.3-48). Winter flounder abundance is lowest in the easternmost extent of the Sound, near the NLDS.

3.4 TOTAL HARVESTABLE CPUE

Seven species of commercially valuable fish comprise the total harvestable CPUE (Table 3.4-1). Mean CPUE for this group has been small (2.5 fish/tow) for the duration of this survey (Figure 3.3-49). The distribution of harvestable fish was spread fairly evenly across LIS habitat areas (Figure 3.3-49). In the fall, the CPUE for harvestable species was highest over mud bottoms of variable depths in both the Western and Central Basins. Accordingly, the CLIS disposal site analysis area had the highest harvestable CPUE in the fall. Relatively high collections of harvestable species also occurred in habitat area 10, a shallow transitional habitat area off Mattituck, New York.

In spring, harvestable size fish were common throughout LIS in shallow habitat areas of all bottom types. Habitat area 17, a shallow mud region at the western end of LIS yielded the highest average CPUE for harvestable species (4.7 fish per tow) for both seasons. The CSDS and NLDS disposal site analysis areas had the largest mean harvestable CPUE in spring. Although differences were slight, relatively higher numbers of harvestable fish were collected from these areas than from their comparison habitat areas, habitat area 11 and 14, respectively.

3.5 JUVENILE AND YOUNG OF THE YEAR (YOY) CPUE

Fourteen species of finfish were used to compare the CPUE of juveniles, excluding young of the year (YOY), among habitat areas and disposal site analysis areas (Table 3.5-1). These species were chosen from the list of 'selected species' based on data availability. Juvenile CPUE is presented collectively to help identify potential nursery areas in LIS. More juveniles were captured in spring sampling during the trawl survey. The regions with the highest CPUE for juveniles, as a group, were transitional habitat areas (habitat area 16, habitat area 18) in the western basin. Overall, shallow habitat areas in the western and central basins tended to yield higher average catches of juveniles than deeper areas or eastern basin habitat areas (Figure 3.5-1). Habitat area 16, a deep transitional site, was the only deep habitat area containing a relatively large abundance of juvenile fish. Sampling at this location in the spring and fall yielded averages of nine and four juveniles per tow, respectively. These averages represented the highest mean CPUE for all locations in each season. The WLIS analysis area supported the highest average juvenile CPUE of all analysis areas in the spring while the CLIS analysis area had the largest mean CPUE for juveniles in the fall.

Ten species of finfish constituted the list of species used to compare the mean CPUE of YOY fish among habitat areas and disposal site analysis areas (Table 3.5-1). Fewer species were used to analyze YOY CPUE by location than juvenile CPUE because limited data are available for this age-class of finfish captured in the trawl survey. As expected, more YOY fish were caught during fall sampling. Young-of-the-year fish were broadly distributed in the fall among LIS habitat areas. Slightly higher catches of YOY fish were found in habitat area 3 and habitat area 10; mean catches at both locations were eight fish per tow (Figure 3.5-2). Both of these habitat areas are shallow transitional areas along the New York shoreline. Relatively low catches of YOY fish occurred during fall sampling in habitat area 12 (mean of 2 fish/tow) and habitat area 14 (mean of 3 fish/tow). Habitat area 10 was also the area with the highest average CPUE for YOY fish in the spring, followed by habitat area 13 and habitat area 14. Differences in mean CPUE for YOY fish among locations sampled in the spring were very slight; in most cases mean catches varied by less than one fish. Average catches showed little variation among the disposal site analysis areas in the spring. The WLIS analysis area contained the highest mean CPUE for YOY fish in the fall. This result corresponded to relatively large collections of YOY fish in habitat areas 15 and 16. Average abundance for YOY fish at each of the remaining disposal site analysis areas was comparable to mean abundance of YOY at their primary comparison habitat areas.

TABLE 3.1-1 CATCH PER UNIT EFFORT (CPUE) FOR HABITAT AREAS AND DISPOSAL SITE ANALYSIS AREAS

Area	Fall CPUE	Spring CPUE	Average Fall And Spring	Total Tows Fall And Spring
1	1911	550	1254	132
2	2359	708	1534	252
3	3636	458	1998	77
4	1259	408	822	111
CLIS	1931	639	1072	214
7	1853	647	1251	560
CLIS-(7)	2000	578	1364	88
5	1601	482	1042	144
6	2161	555	1335	82
9	1551	729	1141	548
CLIS-(5,6,9)	2172	591	889	126
8	987	378	684	179
10	1517	377	909	64
11	656	331	494	330
CSDS	292	197	204	126
12	180	109	145	125
13	761	379	571	114
NLDS	1002	480	736	59
14	558	285	412	85
15	1964	476	1231	11
WLIS	994	885	1071	15
16	1639	752	1197	15
17	1863	333	1100	39
18	1416	434	773	7

CLIS – (7) refers to the stations from CLIS area within habitat area 7

CLIS – (5,6,9) refers to the stations from CLIS area within habitat areas 5, 6, and 9

TABLE 3.1-2 AVERAGE RICHNESS PER TOW FOR HABITAT AREAS AND DISPOSAL SITE ANALYSIS AREAS

Locations	Fall Richness	Spring Richness	Total Fall and Spring	Total Tows Fall and Spring
1	16.47	14.21	15.34	132
2	15.12	13.42	14.27	252
3	15.47	15.22	15.35	77
4	16.44	13.83	15.13	111
CLIS	17.48	16.30	16.89	214
7	16.94	14.18	15.56	560
CLIS-(7)	17.57	14.75	16.16	88
5	17.21	16.66	16.93	144
6	18.93	17.57	18.25	82
9	16.44	14.80	15.62	548
CLIS-(5.6.9)	17.21	17.62	17.42	126
8	17.15	13.90	15.52	179
10	16.10	15.09	15.59	64
11	12.95	12.67	12.81	330
CSDS	12.16	11.04	11.60	126
12	9.59	8.64	9.12	125
13	13.12	9.52	11.32	114
NLDS	13.43	9.89	11.66	59
14	11.68	14.90	13.29	85
15	14.50	12.44	13.47	11
WLIS	13.25	12.85	13.05	15
16	17.60	17.15	17.38	15
17	13.60	11.28	12.44	39
18	12.00	14.25	13.13	7

CLIS – (7) refers to the stations from CLIS area within habitat area 7

CLIS – (5,6,9) refers to the stations from CLIS area within habitat areas 5, 6, and 9

TABLE 3.4-1 LIST OF SPECIES AND MINIMUM LENGTHS USED IN HARVESTABLE CPUE

Species	Minimum Harvestable Length (mm)
Black sea bass (*Centropristes striata*)	254
Bluefish (*Pomatomus saltatrix*)	207
Scup (*Stenotomus chrysops*)	205
Summer flounder (*Etropus microstomus*)	356
Tautog (*Tautoga onitis*)	356
Weakfish (*Cynoscion regalis*)	457
Winter flounder (*Pseudopleuronectes americanus*)	305

TABLE 3.5-1 LIST OF SPECIES CONSTITUTING JUVENILE AND YOUNG-OF-THE-YEAR (YOY) CPUE

Juvenile CPUE	YOY CPUE
Alewife *Alosa pseudoharengus*	Alewife *Alosa pseudoharengus*
American shad *Alosa sapidissima*	American shad *Alosa sapidissima*
Black sea bass *Centropristis striata*	Atlantic herring *Clupea harengus*
Bluefish *Pomatomus saltatrix*	Black sea bass *Centropristis striata*
Butterfish *Peprilus triacanthus*	Bluefish *Pomatomus saltatrix*
Northern searobin *Prionotus carolinus*	Fourspot flounder *Paralichthys oblongus*
Red hake *Urophycis chuss*	Little skate *Raja erinacea*
Scup *Stenotomus chrysops*	Scup *Stenotomus chrysops*
Smooth Dogfish *Mustelus canis*	Striped searobin *Prionotus evolans*
Striped searobin *Prionotus evolans*	Weakfish *Cynoscion regalis*
Summer Flounder *Paralichthys dentatus*	
Tautog *Tautoga onitis*	
Weakfish *Cynoscion regalis*	
Winter Flounder *Pseudopleuronectes americanus*	

Figures 3.1-1 through 3.1-12

and

Figures 3.2-1 through 3.2-4

FIGURE 3.3-1 AVERAGE CPUE OF ALEWIVES BY YEAR AND SEASON 1984-2000

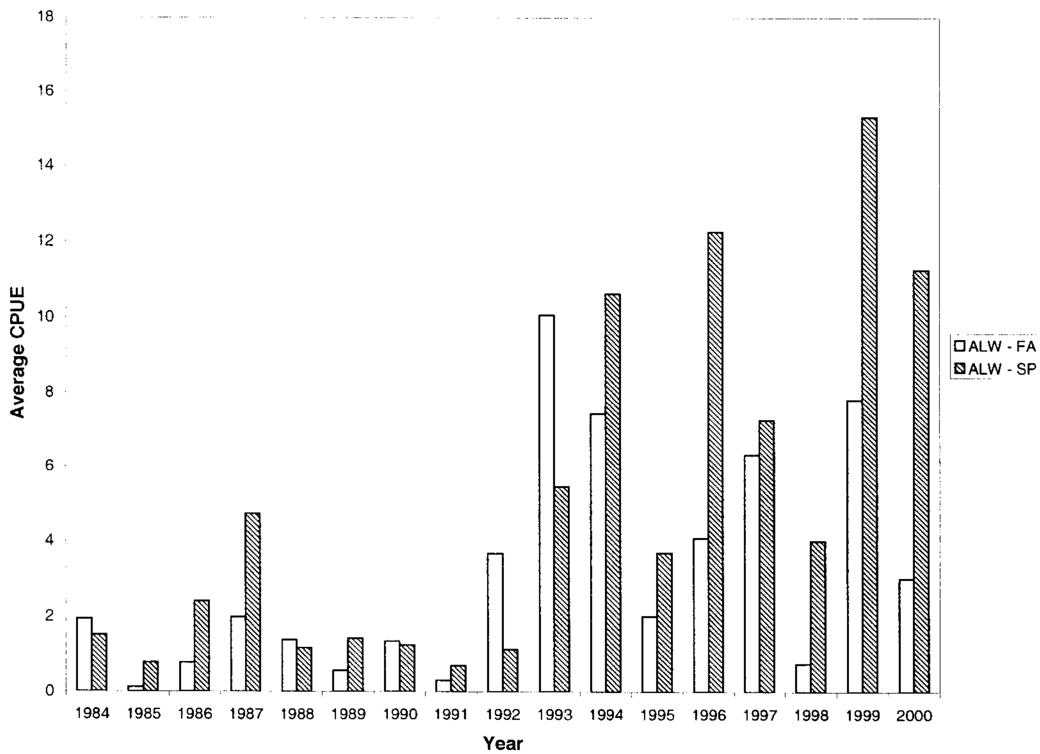


FIGURE 3.3-2 AVERAGE CPUE OF ALEWIVES BY LOCATION AND SEASON 1984-2000

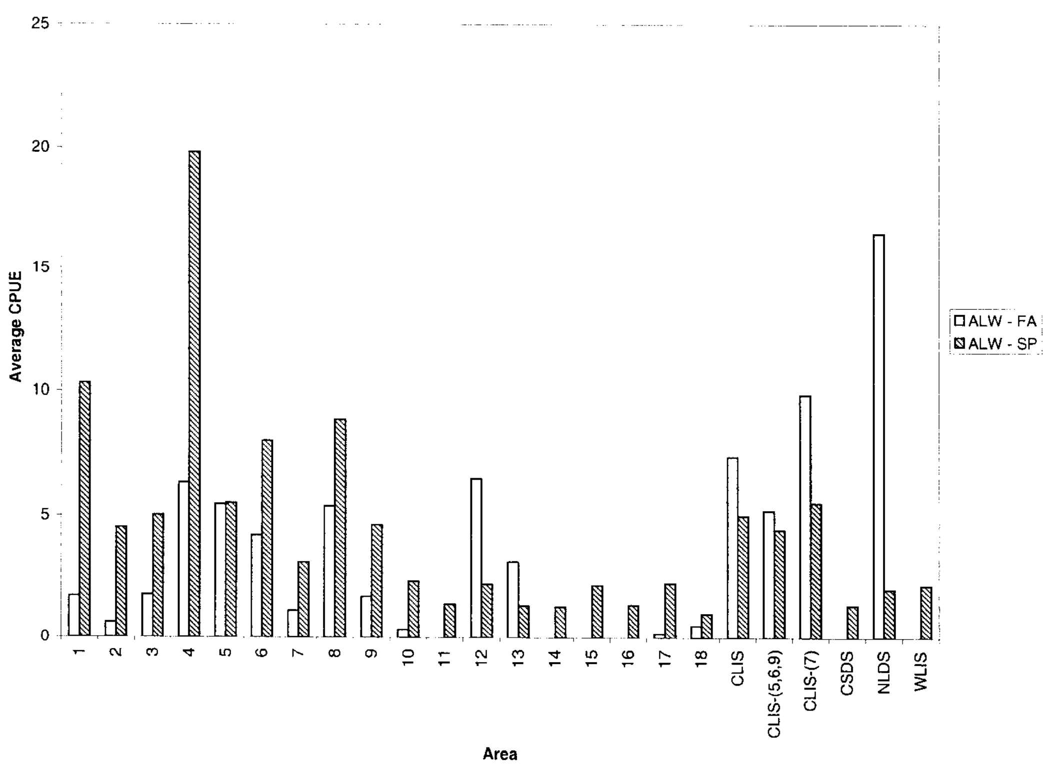


FIGURE 3.3-3 AVERAGE CPUE OF AMERICAN LOBSTER BY YEAR AND SEASON 1984-2000

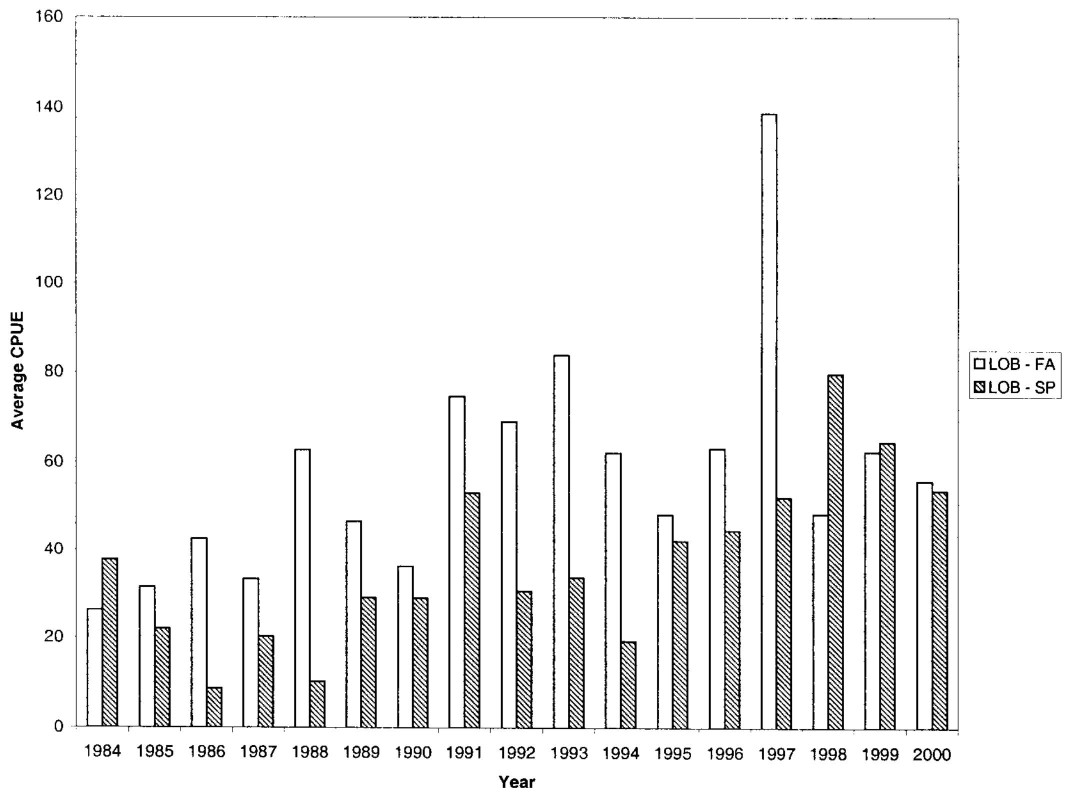


FIGURE 3.3-4 AVERAGE CPUE OF AMERICAN LOBSTER BY LOCATION AND SEASON 1984-2000

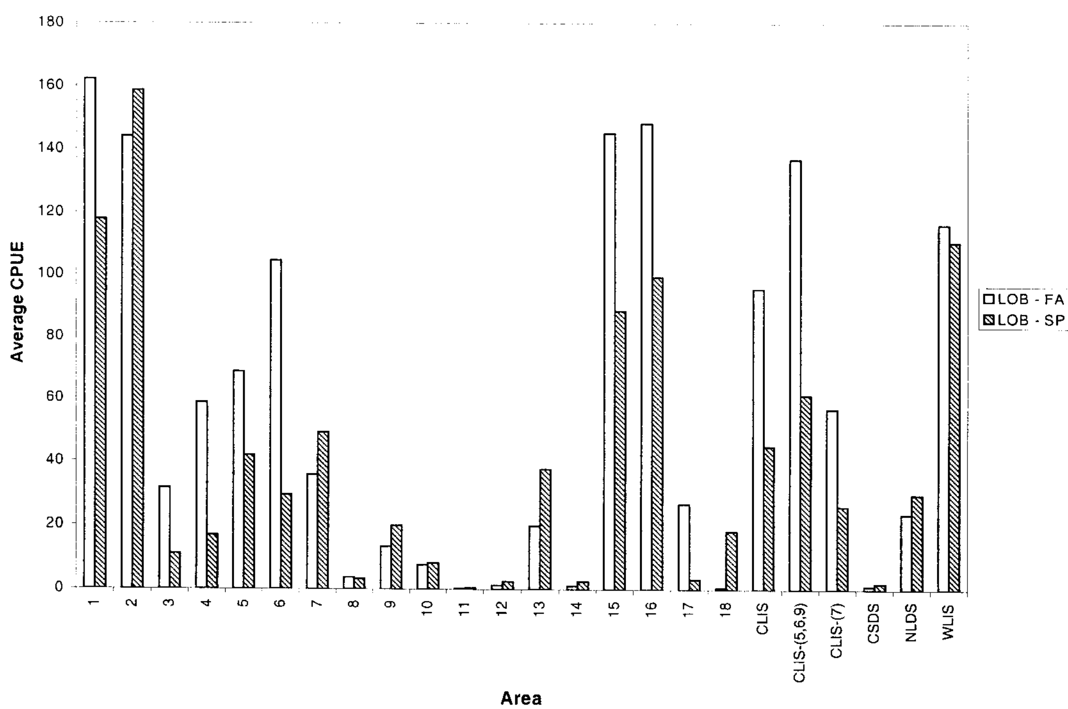


FIGURE 3.3-5 AVERAGE CPUE OF AMERICAN SHAD BY YEAR AND SEASON 1984-2000

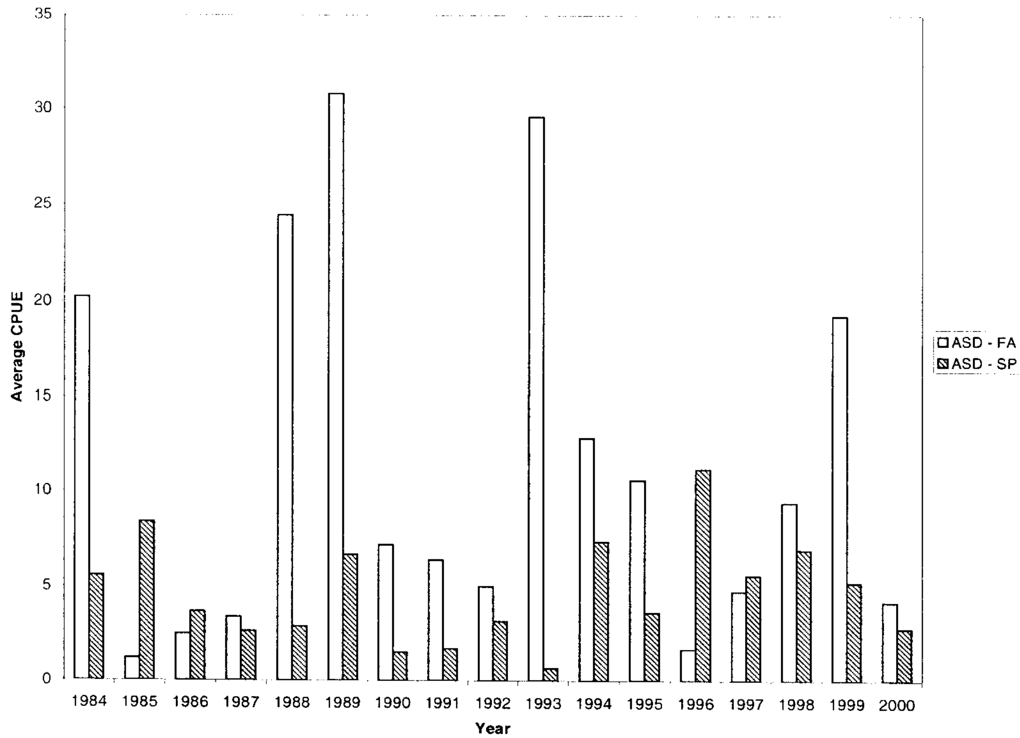


FIGURE 3.3-6 AVERAGE CPUE OF AMERICAN SHAD BY LOCATION AND SEASON 1984-2000

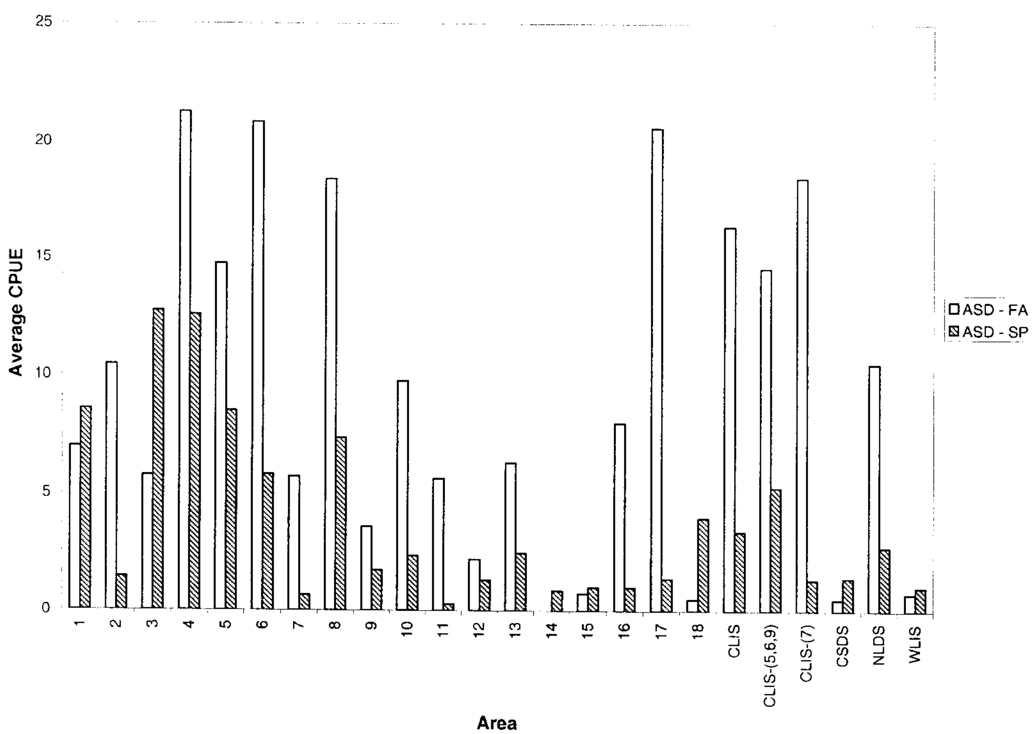


FIGURE 3.3-7 AVERAGE CPUE OF ATLANTIC HERRING BY YEAR AND SEASON 1984-2000

FIGURE 3.3-8 AVERAGE CPUE OF ATLANTIC HERRING BY LOCATION AND SEASON 1984-2000

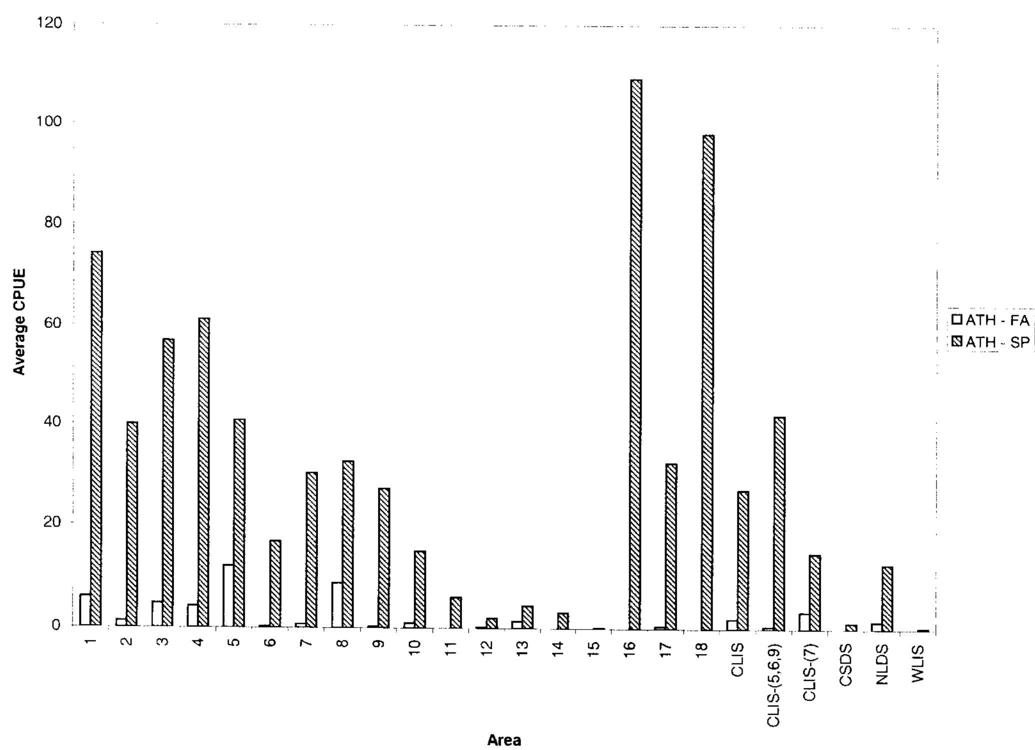


FIGURE 3.3-9 AVERAGE CPUE OF BLACK SEA BASS BY YEAR AND SEASON 1984-2000

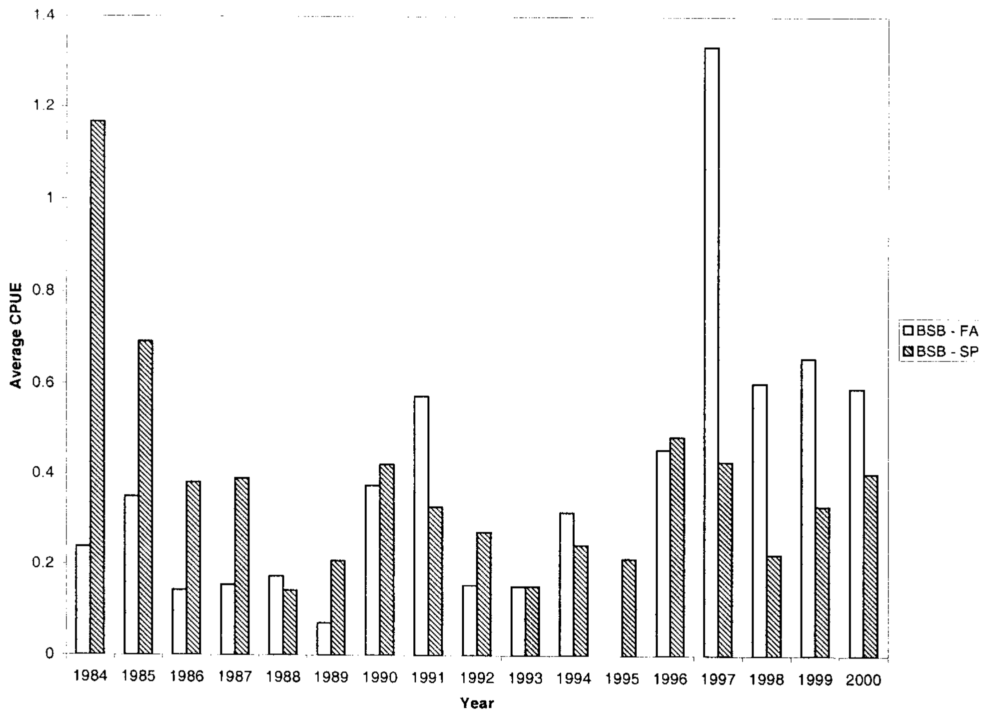


FIGURE 3.3-10 AVERAGE CPUE OF BLACK SEA BASS BY LOCATION AND SEASON 1984-2000

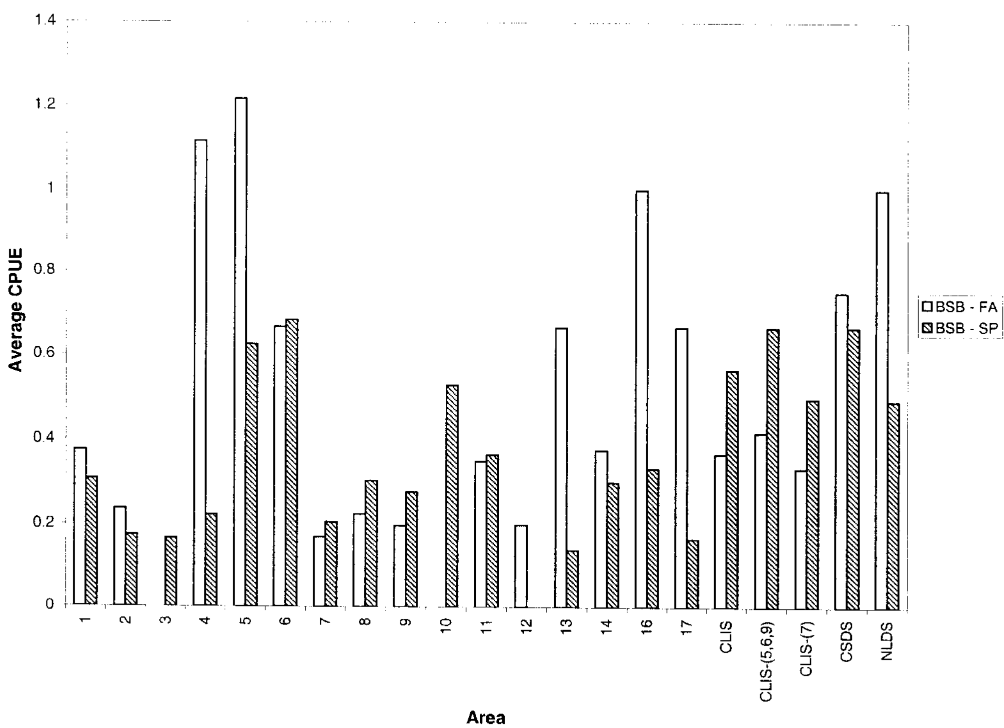


FIGURE 3.3-11 AVERAGE CPUE OF BLUEFISH BY YEAR AND SEASON 1984-2000

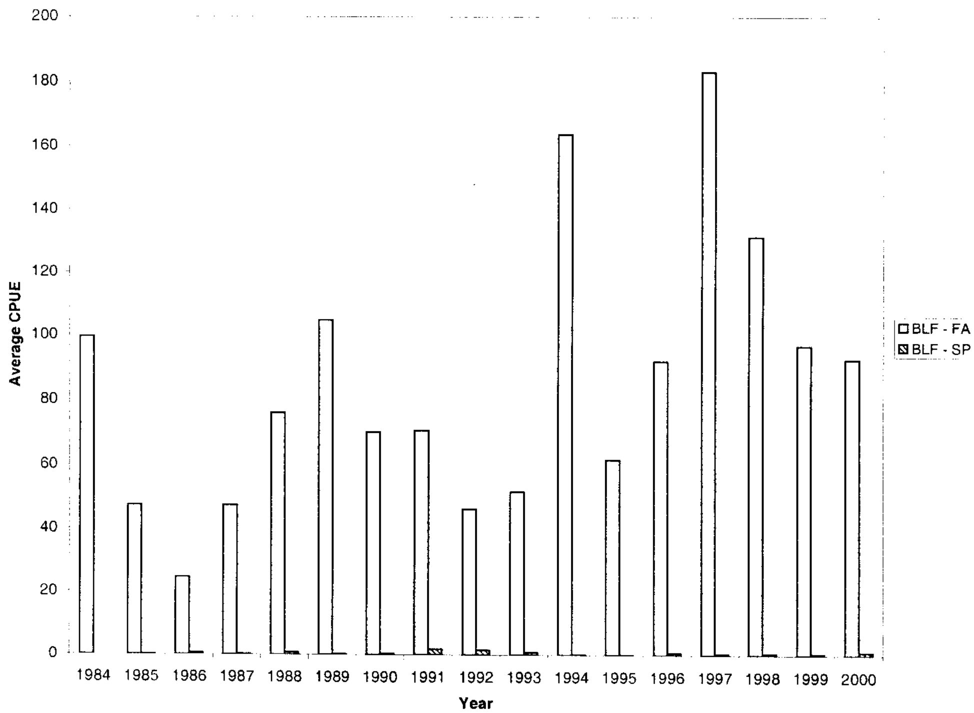


FIGURE 3.3-12 AVERAGE CPUE OF BLUEFISH BY LOCATION AND SEASON 1984-2000

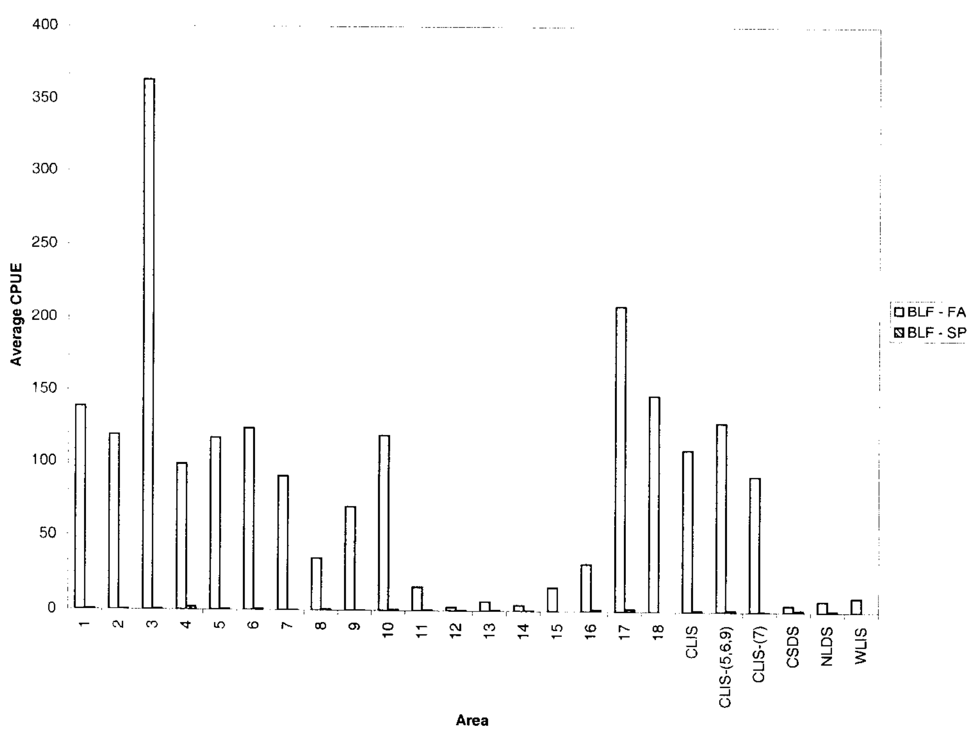


FIGURE 3.3-13 AVERAGE CPUE OF BUTTERFISH BY YEAR AND SEASON 1984-2000

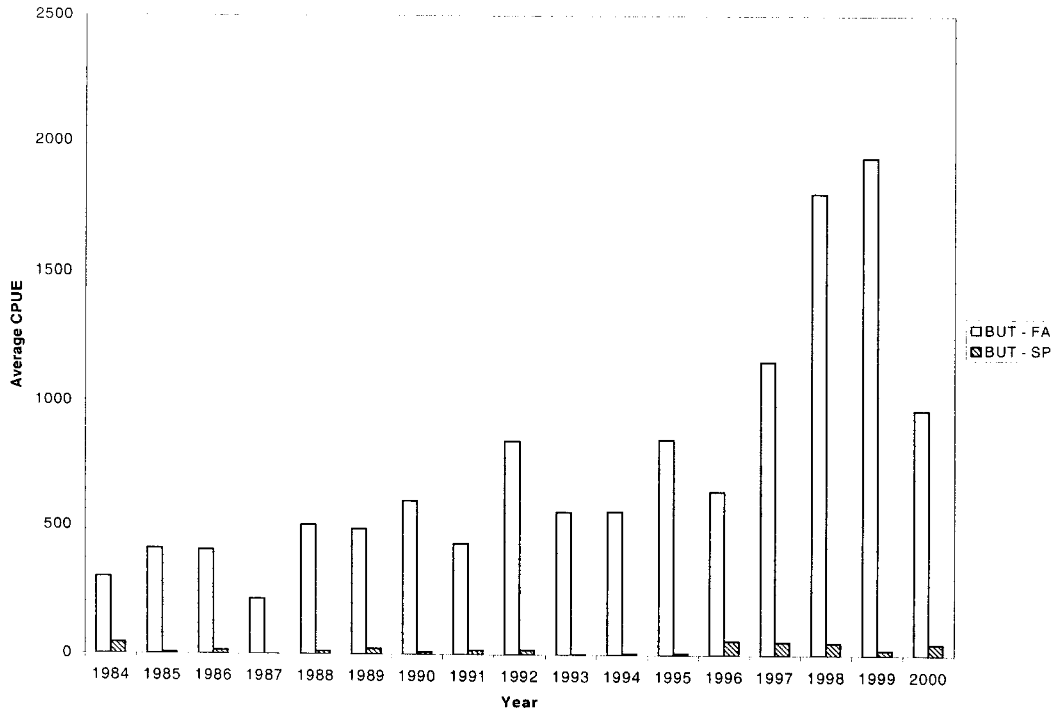


FIGURE 3.3-14 AVERAGE CPUE OF BUTTERFISH BY LOCATION AND SEASON 1984-2000

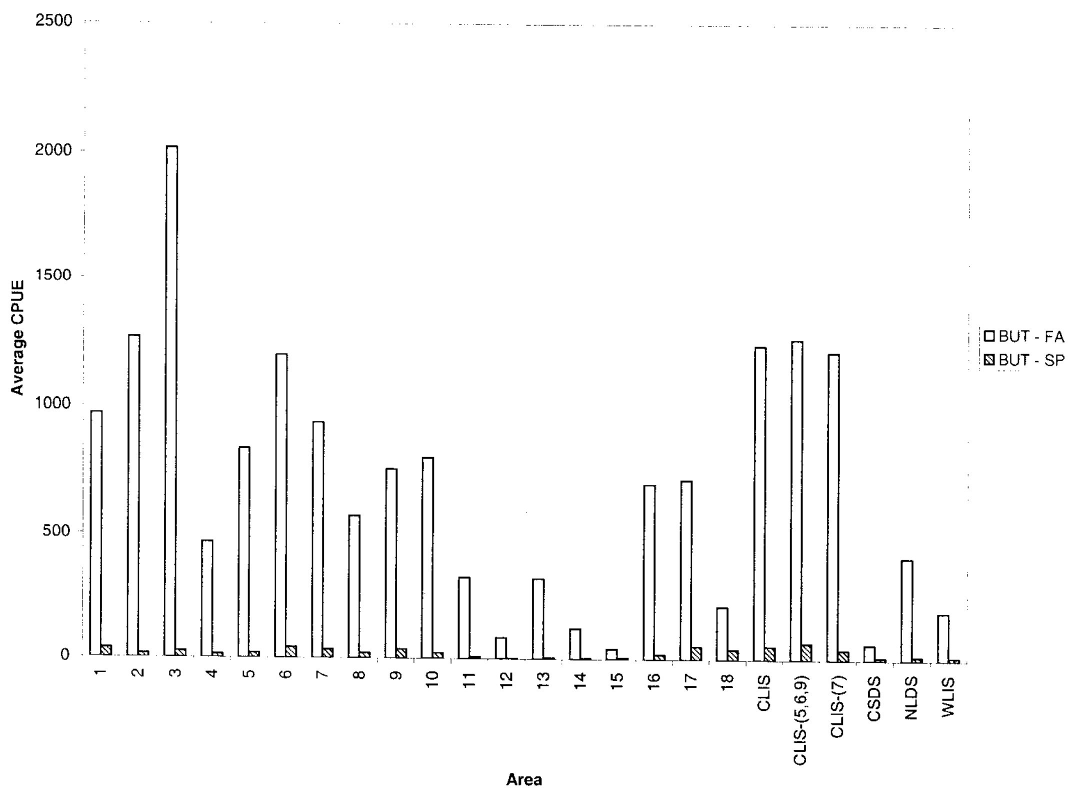


FIGURE 3.3-15 AVERAGE CPUE OF CUNNER BY YEAR AND SEASON 1984-2000

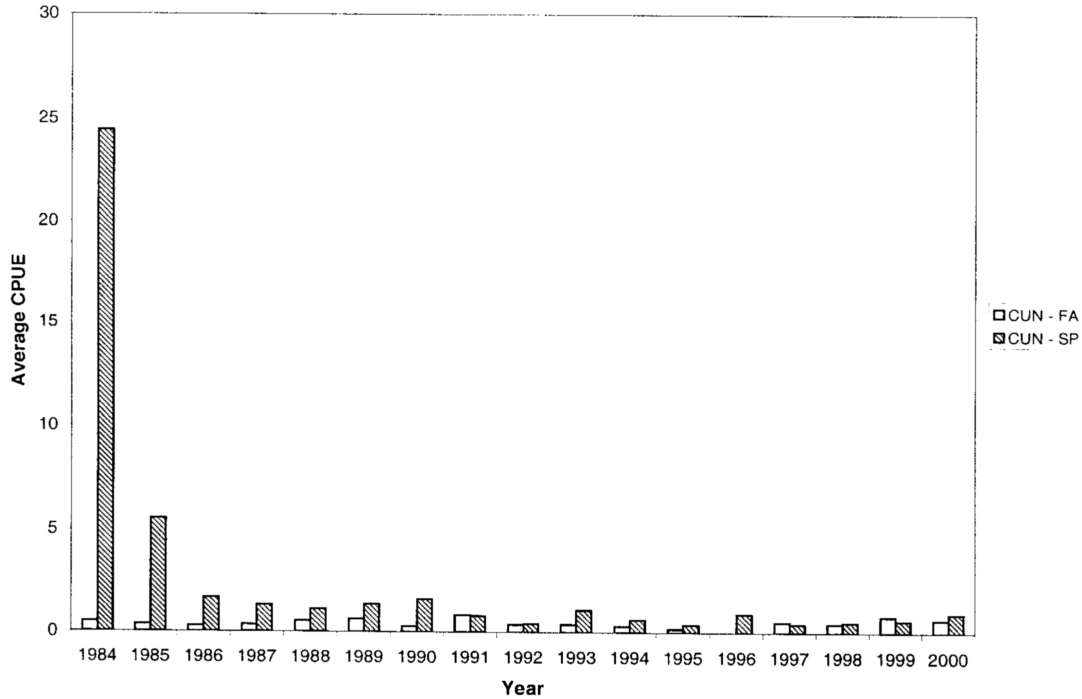


FIGURE 3.3-16 AVERAGE CPUE OF CUNNER BY LOCATION AND SEASON 1984-2000

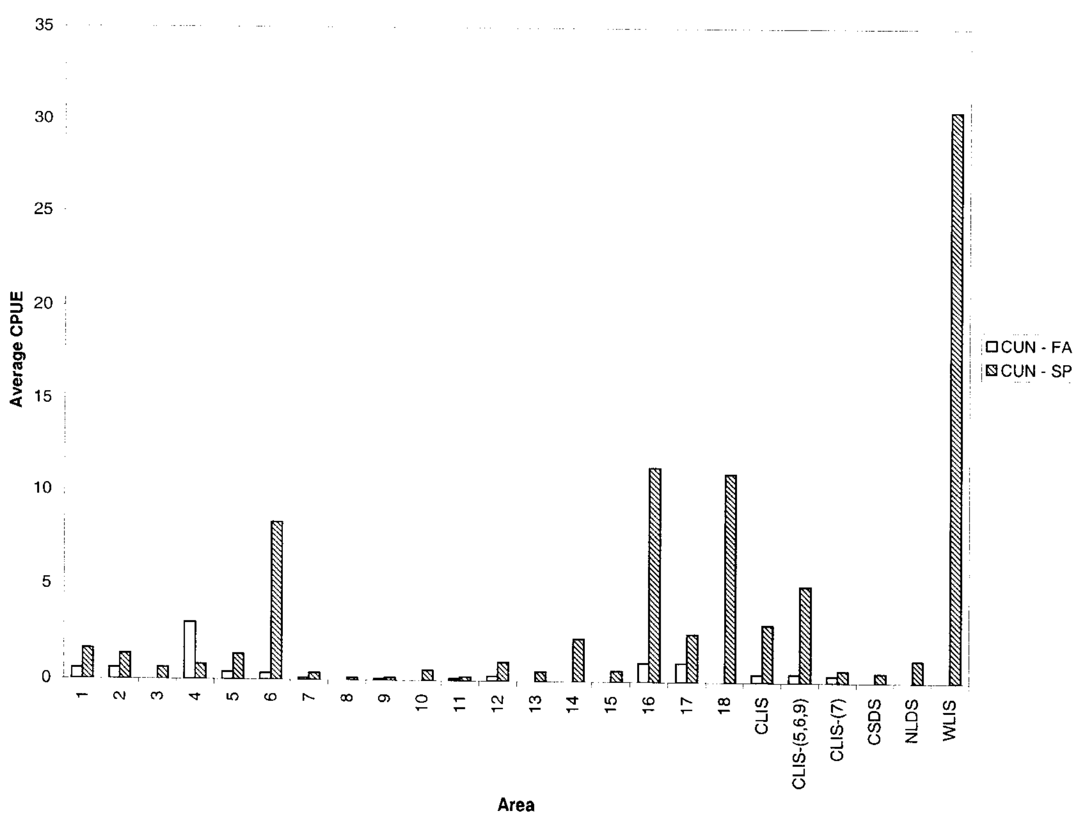


FIGURE 3.3-17 AVERAGE CPUE OF FOURBEARD ROCKLING BY YEAR AND SEASON 1984-2000

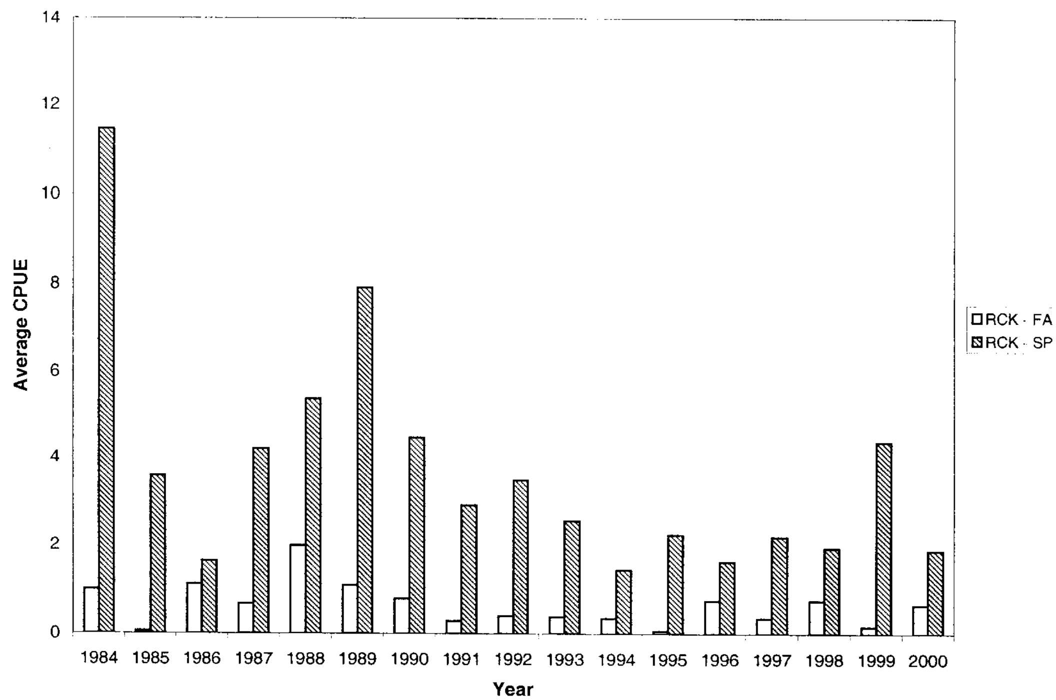


FIGURE 3.3-18 AVERAGE CPUE OF FOURBEARD ROCKLING BY LOCATION AND SEASON 1984-2000

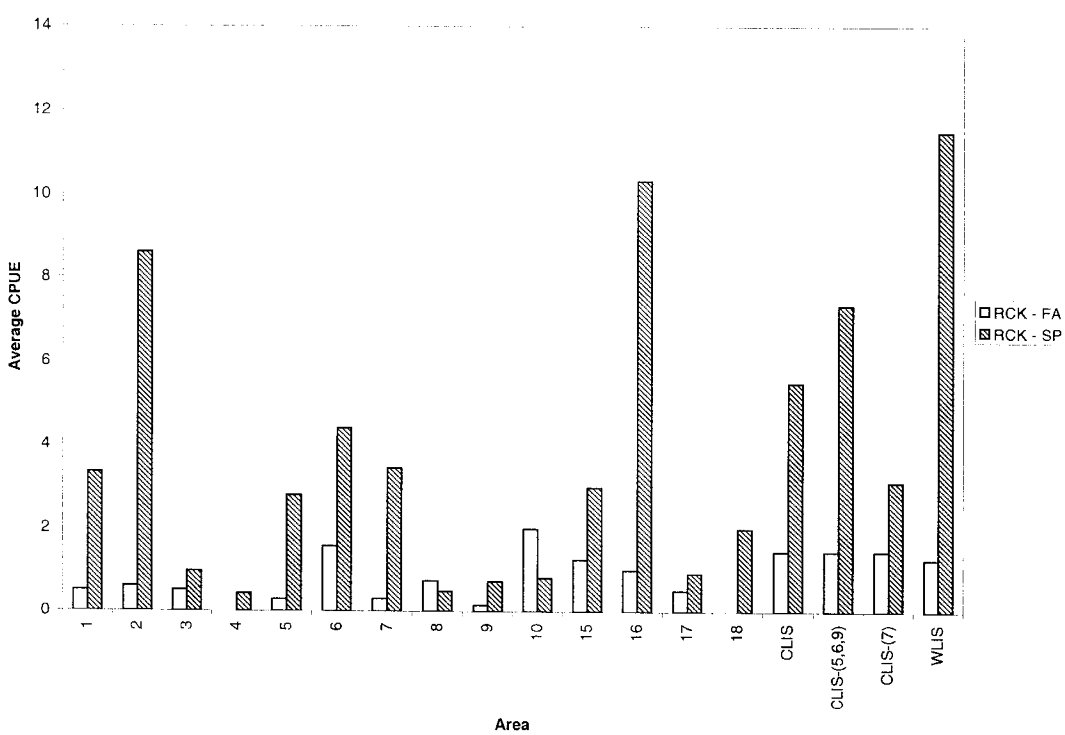


FIGURE 3.3-19 AVERAGE CPUE OF FOURSPOT FLOUNDER BY YEAR AND SEASON 1984-2000

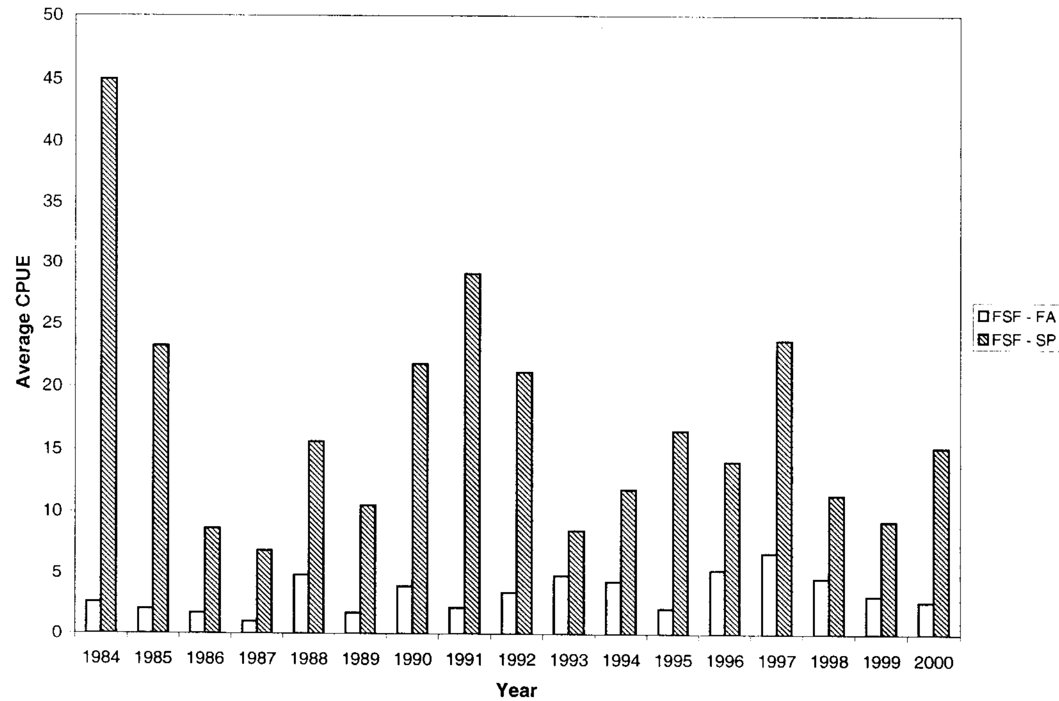


FIGURE 3.3-20 AVERAGE CPUE OF FOURSPOT FLOUNDER BY LOCATION AND SEASON 1984-2000

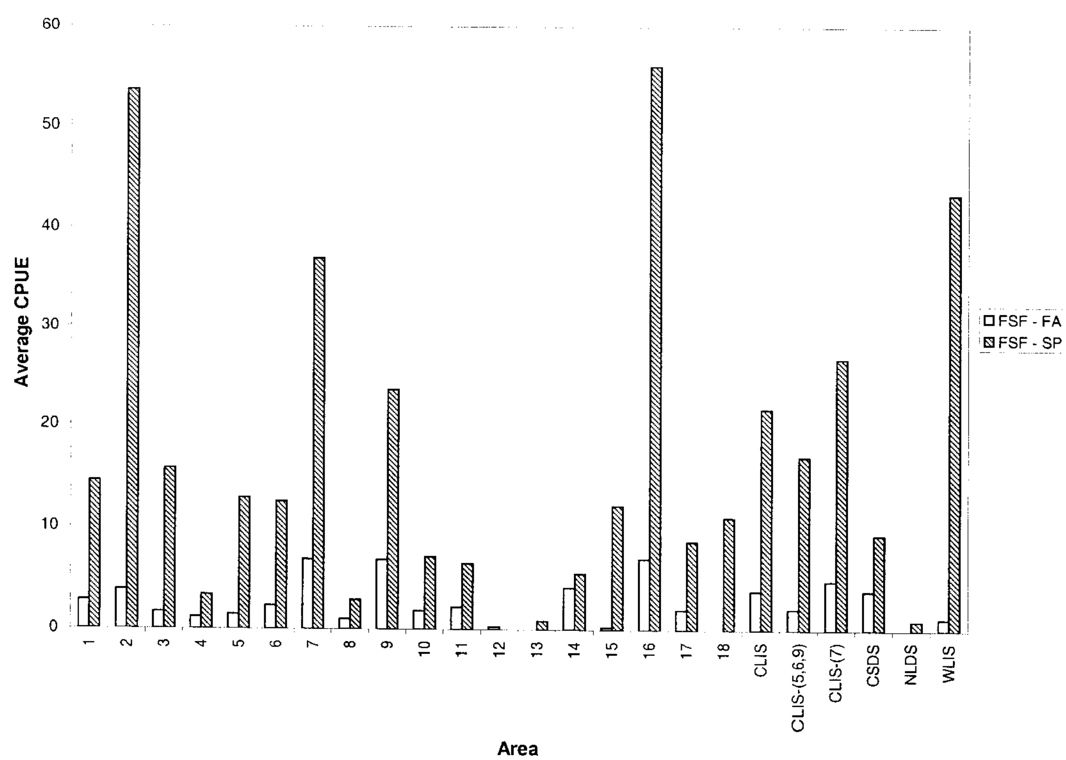


FIGURE 3.3-21 AVERAGE CPUE OF HOGCHOKER BY YEAR AND SEASON 1984-2000

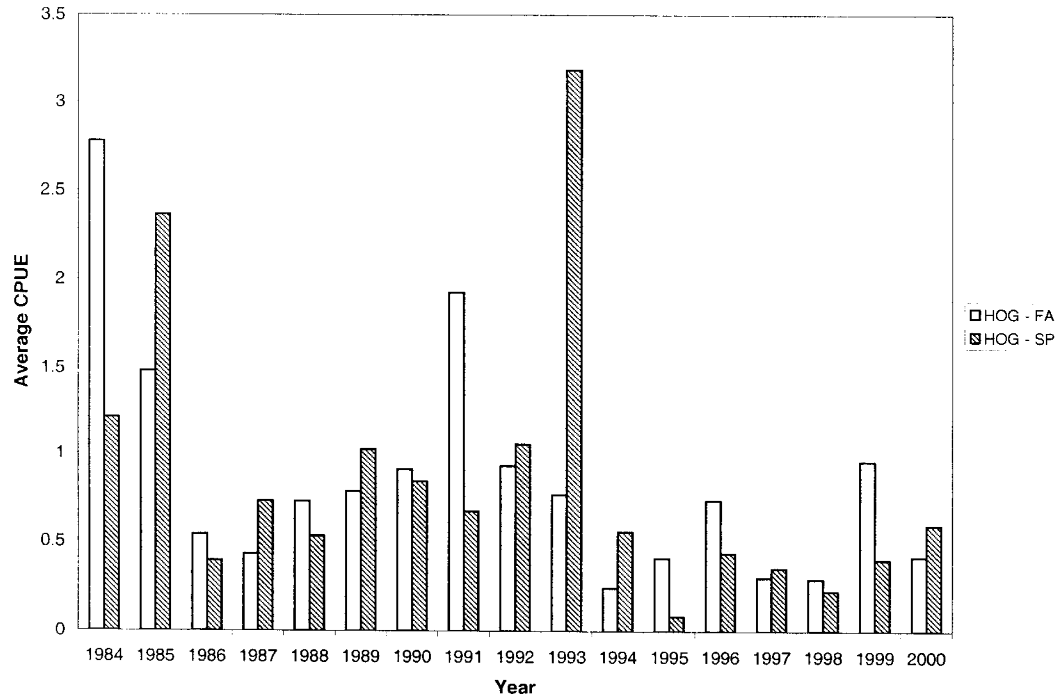


FIGURE 3.3-22 AVERAGE CPUE OF HOGCHOKER BY LOCATION AND SEASON 1984-2000

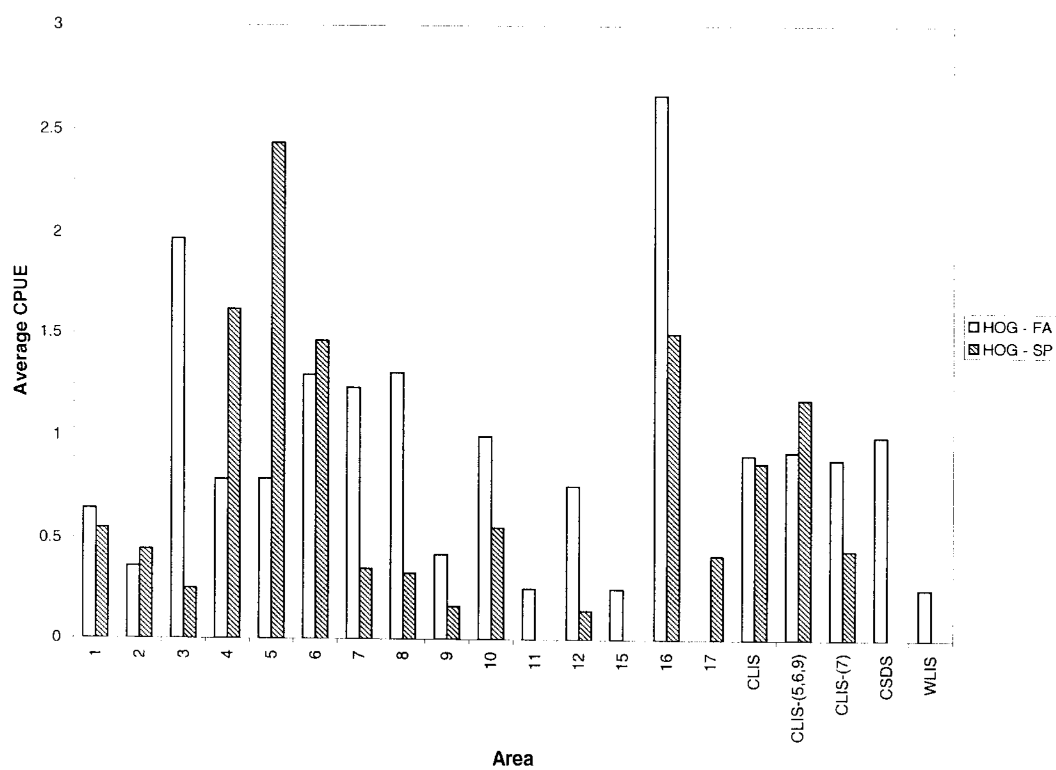


FIGURE 3.3-23 AVERAGE CPUE OF LITTLE SKATE BY YEAR AND SEASON 1984-2000

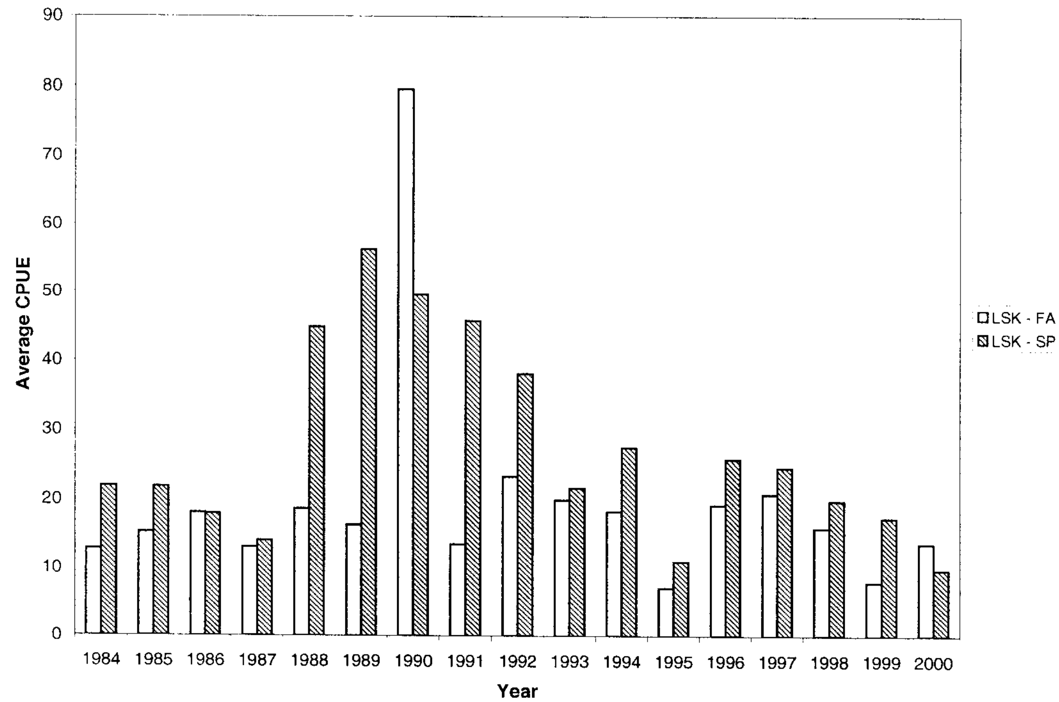


FIGURE 3.3-24 AVERAGE CPUE OF LITTLE SKATE BY LOCATION AND SEASON 1984-2000

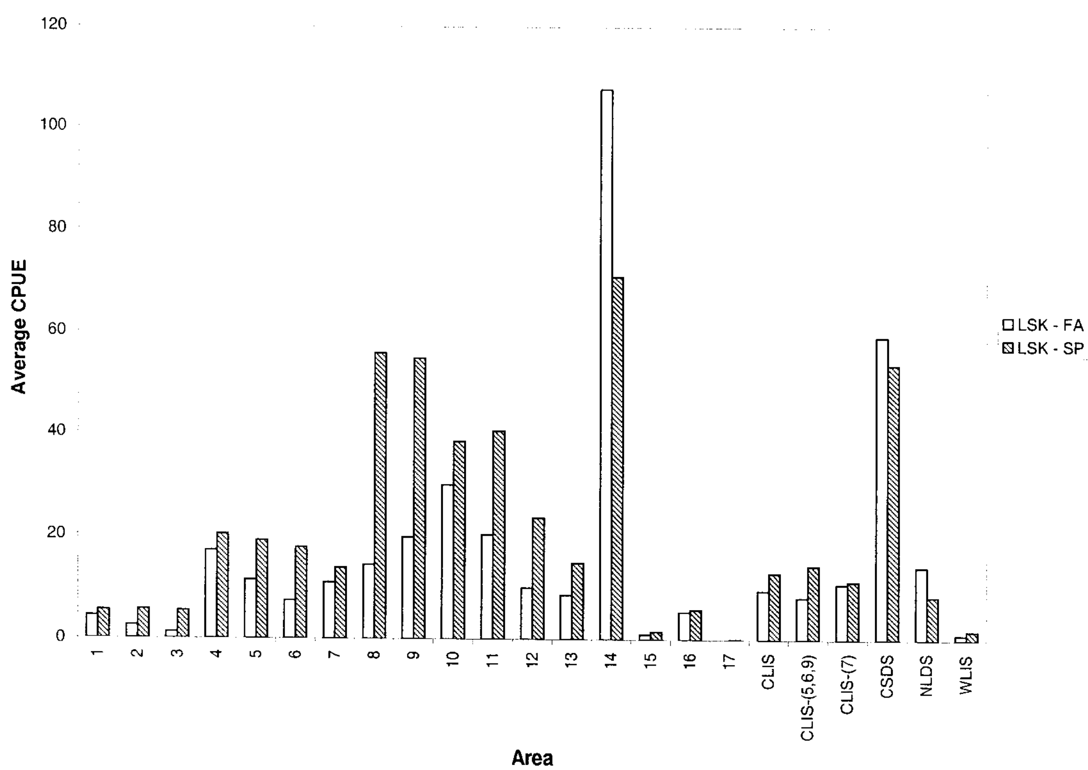


FIGURE 3.3-25 AVERAGE CPUE OF LONG-FINNED SQUID BY YEAR AND SEASON 1984-2000

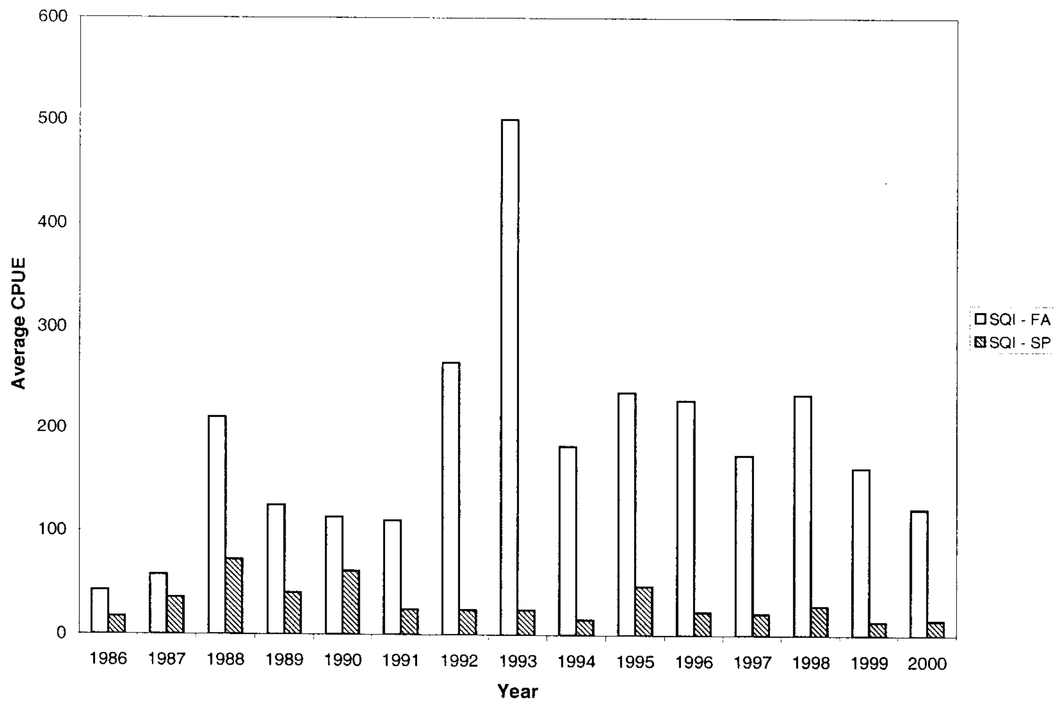


FIGURE 3.3-26 AVERAGE CPUE OF LONG-FINNED BY LOCATION AND SEASON 1984-2000

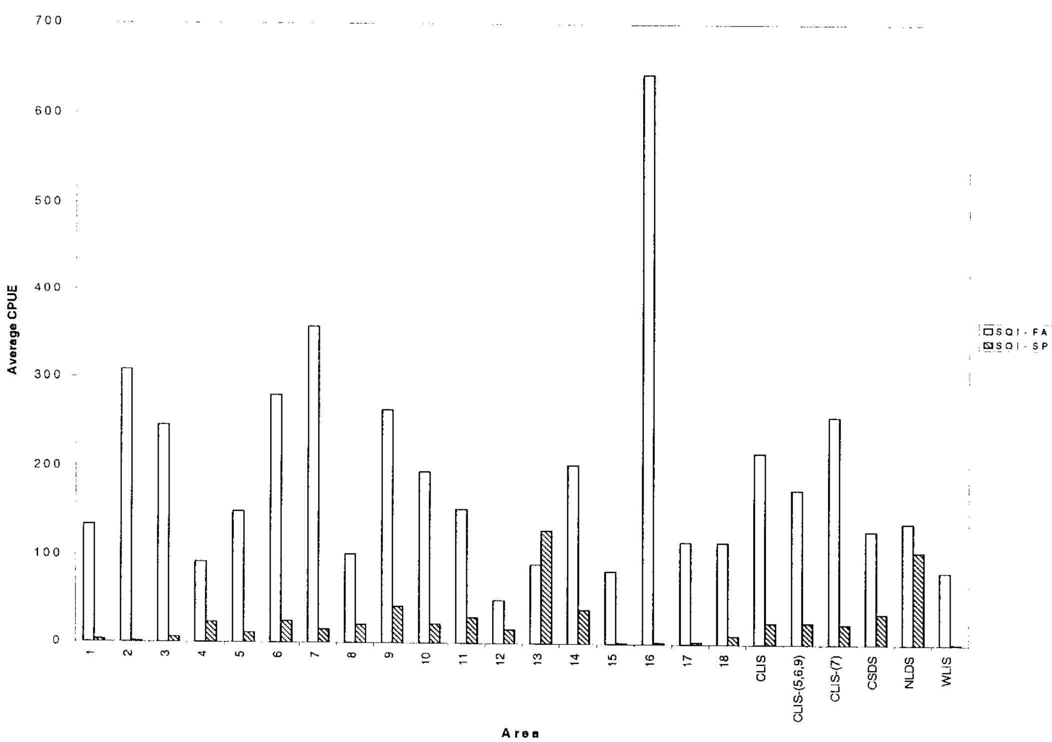


FIGURE 3.3-27 AVERAGE CPUE OF NORTHERN SEAROBIN BY YEAR AND SEASON 1984-2000

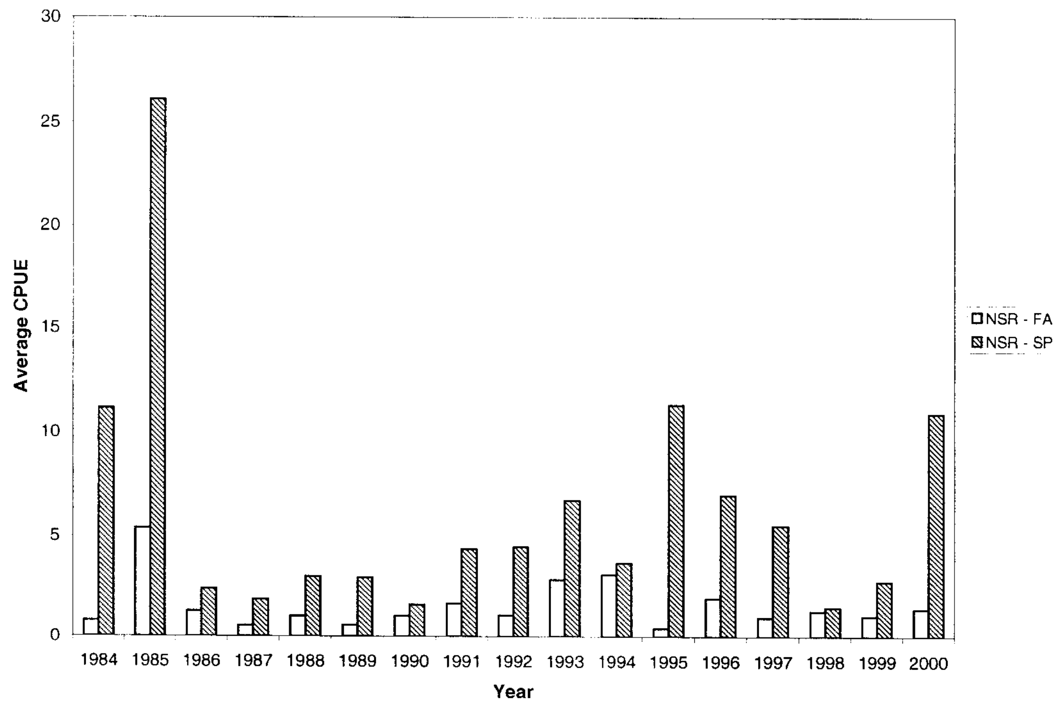


FIGURE 3.3-28 AVERAGE CPUE OF NORTHERN SEAROBIN BY LOCATION AND SEASON 1984-2000

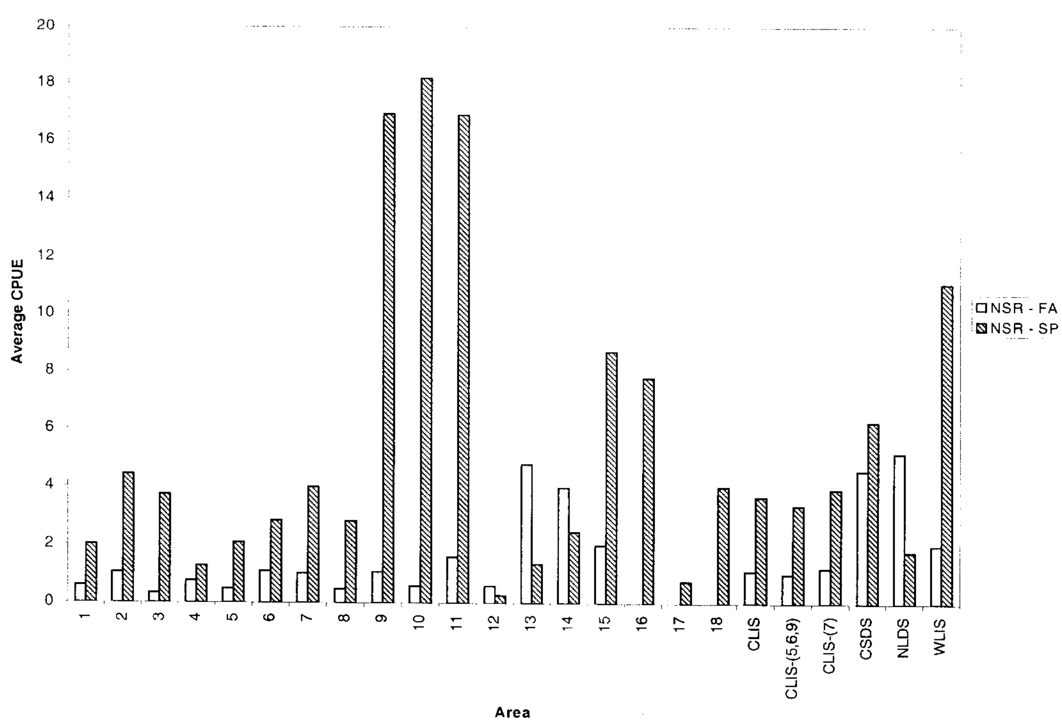


FIGURE 3.3-29 AVERAGE CPUE OF RED HAKE BY YEAR AND SEASON 1984-2000

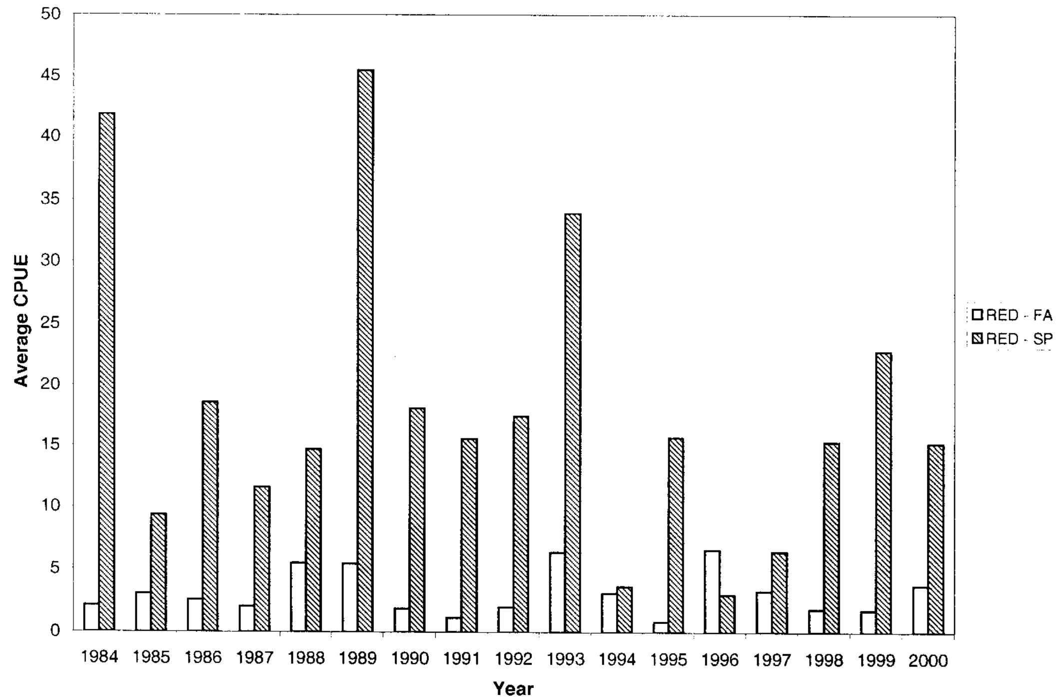


FIGURE 3.3-30 AVERAGE CPUE OF RED HAKE BY LOCATION AND SEASON 1984-2000

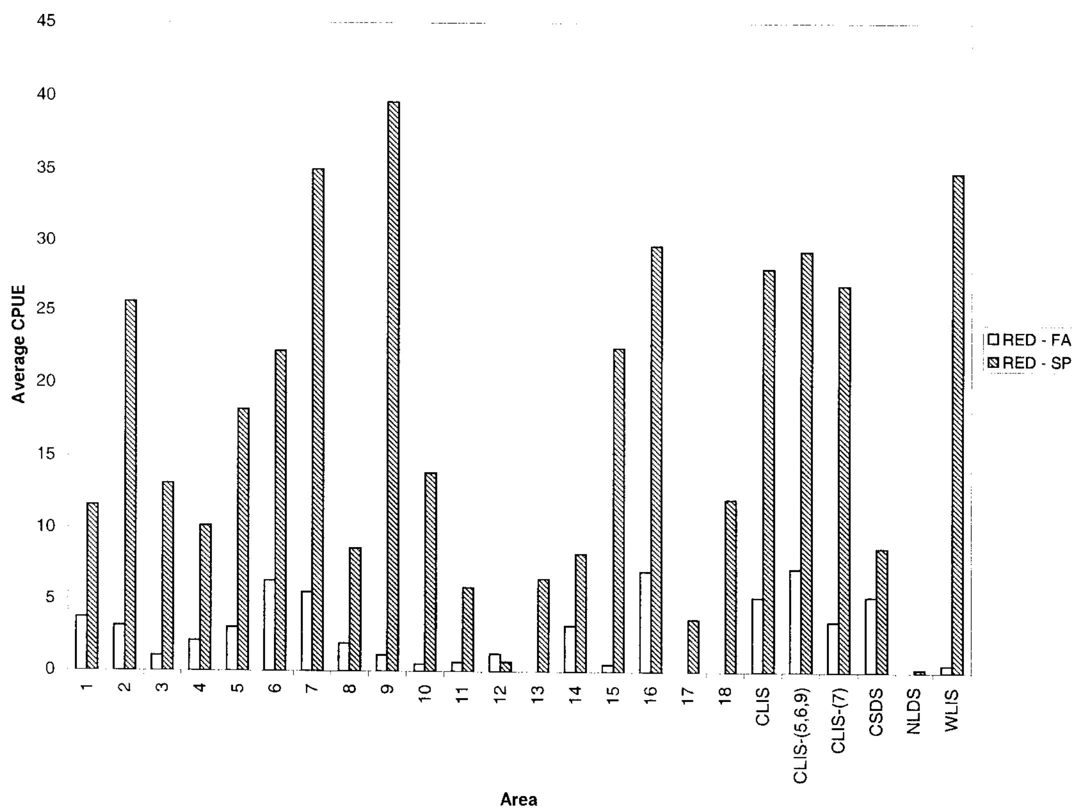


FIGURE 3.3-31 AVERAGE CPUE OF SCUP BY YEAR AND SEASON 1984-2000

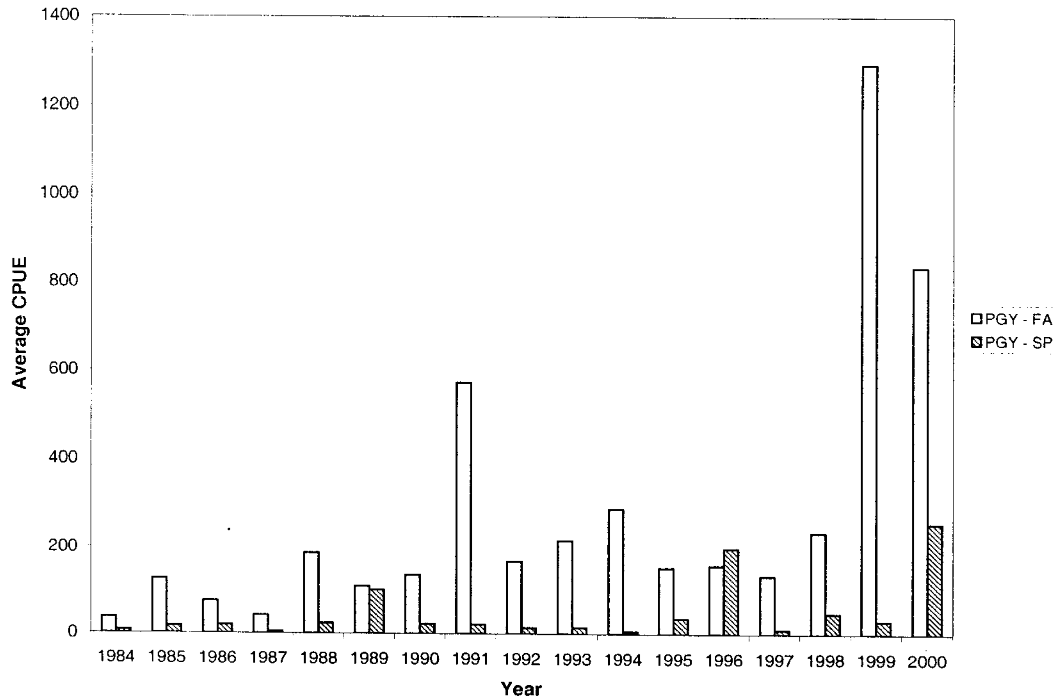


FIGURE 3.3-32 AVERAGE CPUE OF SCUP BY LOCATION AND SEASON 1984-2000

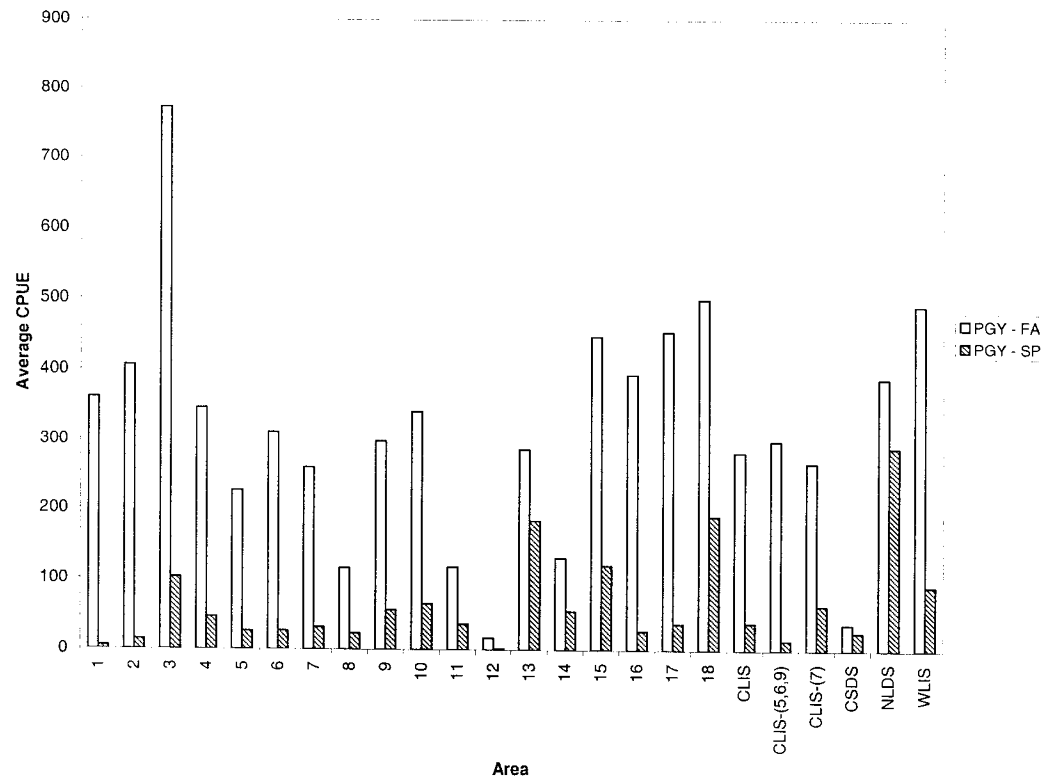


FIGURE 3.3-33 AVERAGE CPUE OF SILVER HAKE BY YEAR AND SEASON 1984-2000

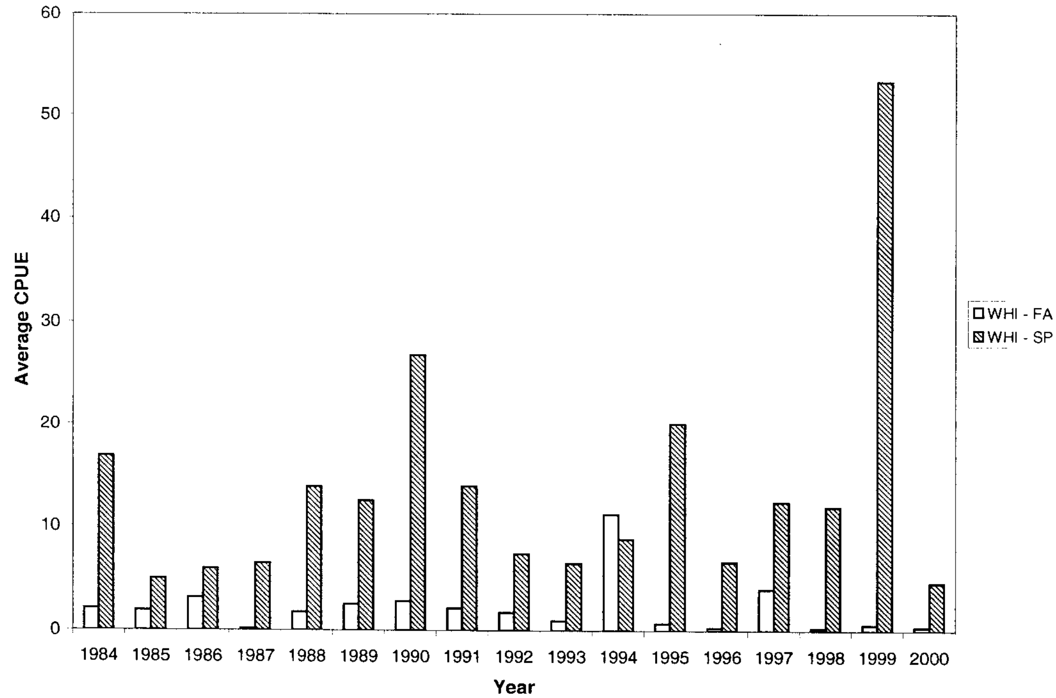


FIGURE 3.3-34 AVERAGE CPUE OF SILVER HAKE BY LOCATION AND SEASON 1984-2000

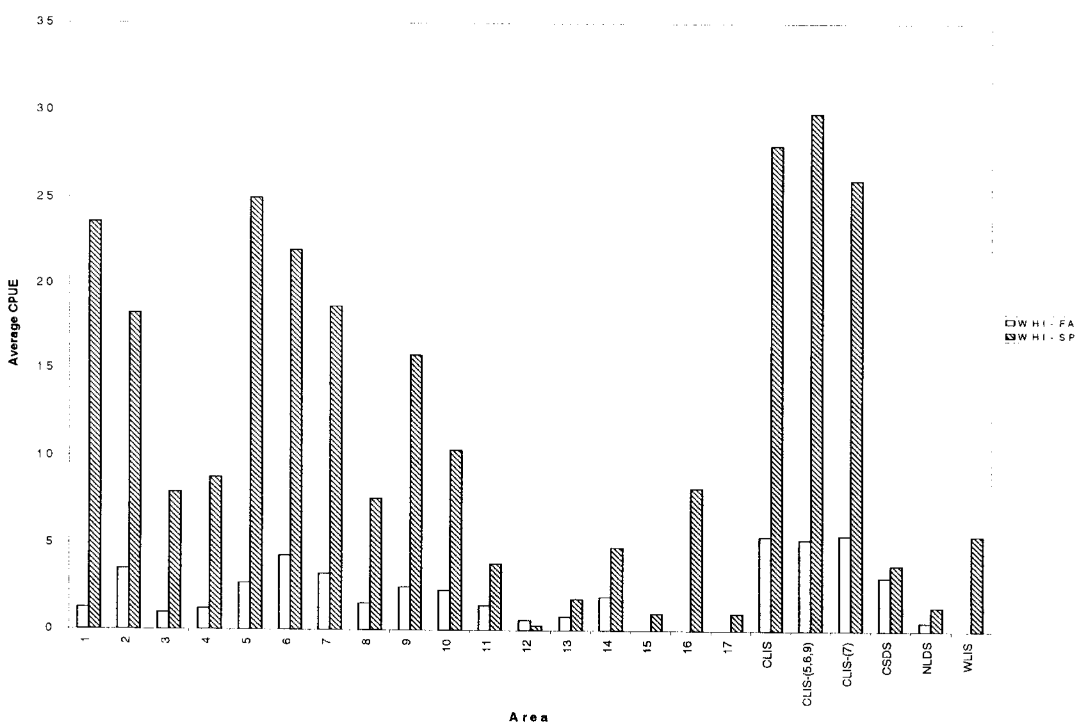


FIGURE 3.3-35 AVERAGE CPUE OF SMOOTH DOGFISH BY YEAR AND SEASON 1984-2000

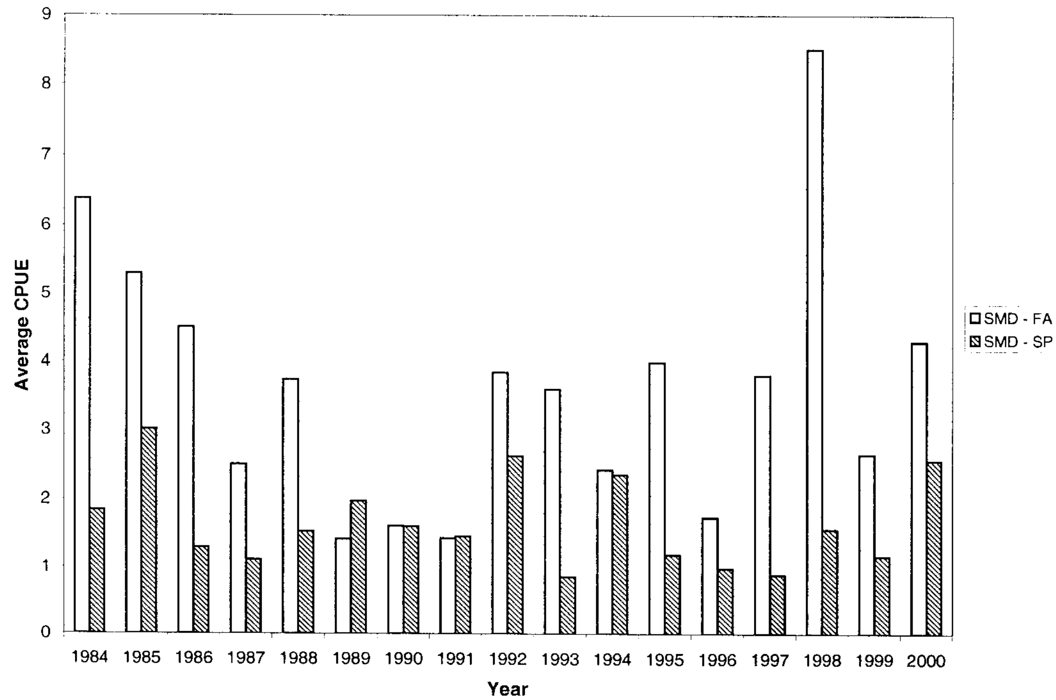


FIGURE 3.3-36 AVERAGE CPUE OF SMOOTH DOGFISH BY LOCATION AND SEASON 1984-2000

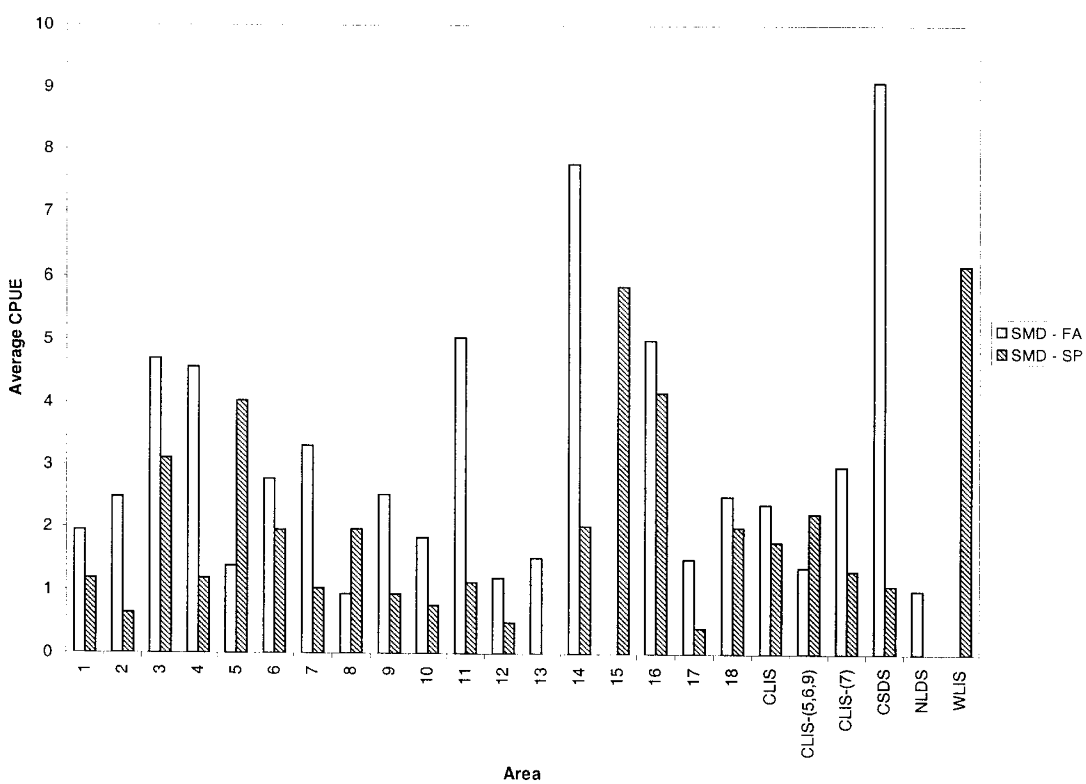


FIGURE 3.3-37 AVERAGE CPUE OF STRIPED SEAROBIN BY YEAR AND SEASON 1984-2000

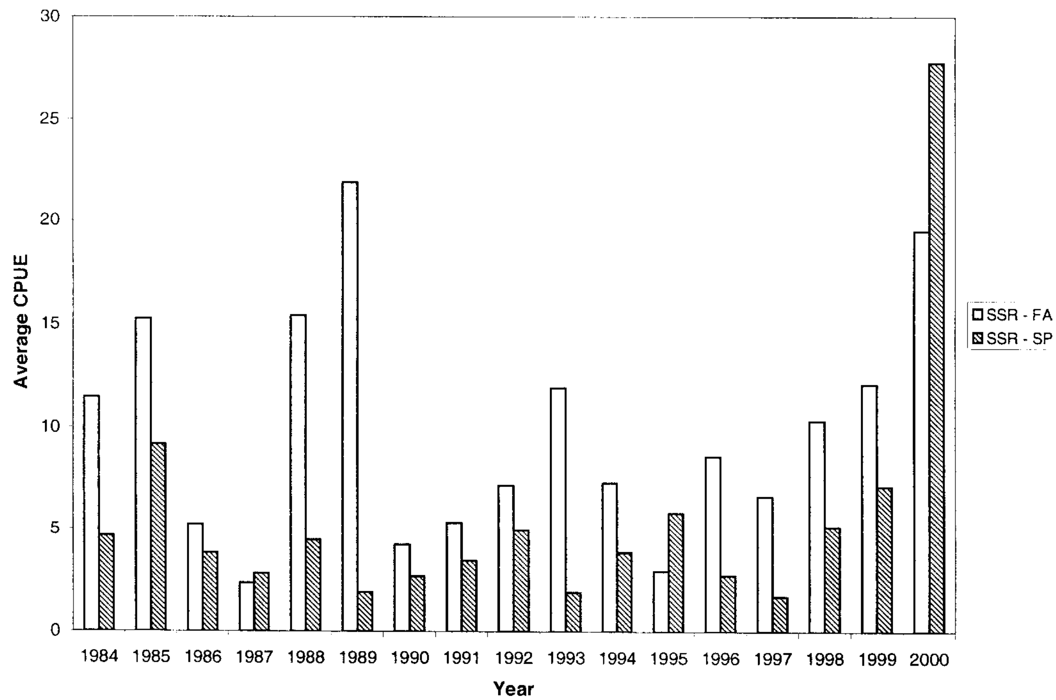


FIGURE 3.3-38 AVERAGE CPUE OF STRIPED SEAROBIN BY LOCATION AND SEASON 1984-2000

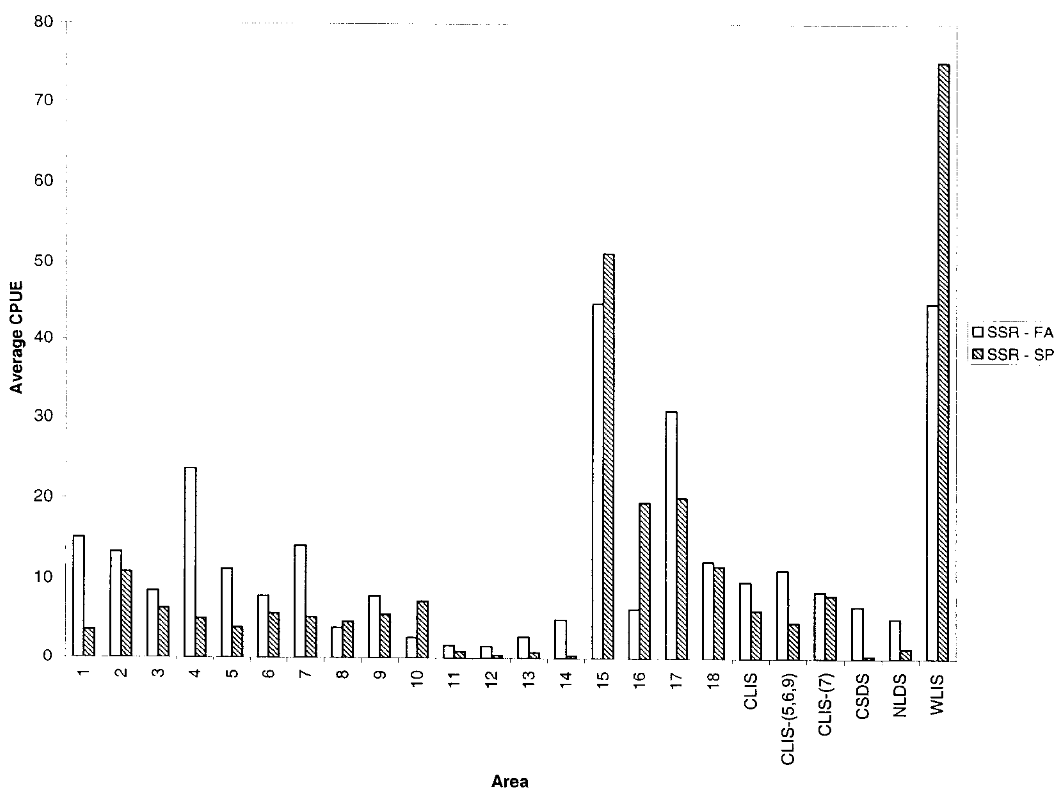


FIGURE 3.3-39 AVERAGE CPUE OF SUMMER FLOUNDER BY YEAR AND SEASON 1984-2000

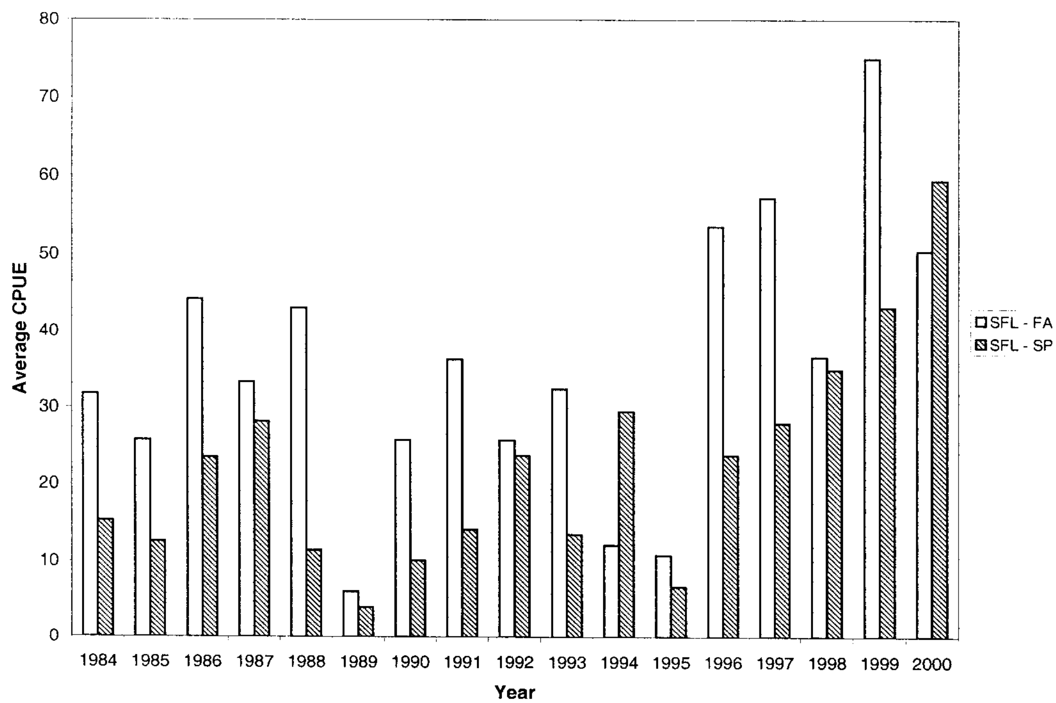


FIGURE 3.3-40 AVERAGE CPUE OF SUMMER FLOUNDER BY LOCATION AND SEASON 1984-2000

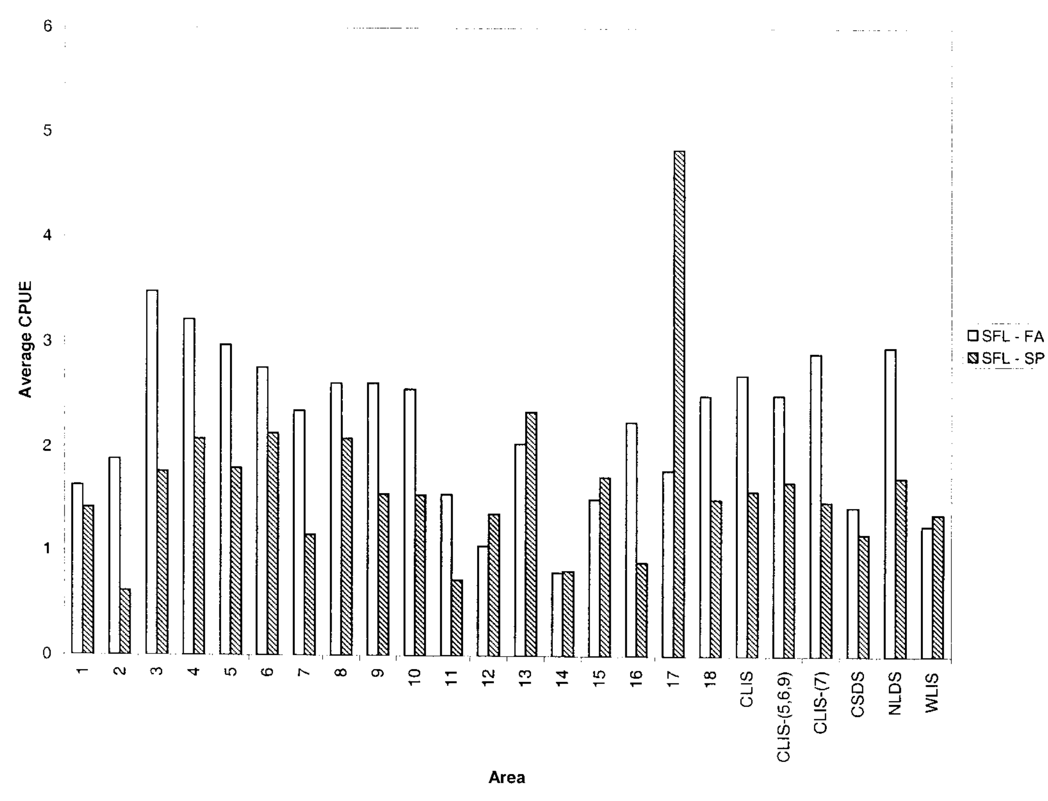


FIGURE 3.3-41 AVERAGE CPUE OF TAUTOG BY YEAR AND SEASON 1984-2000

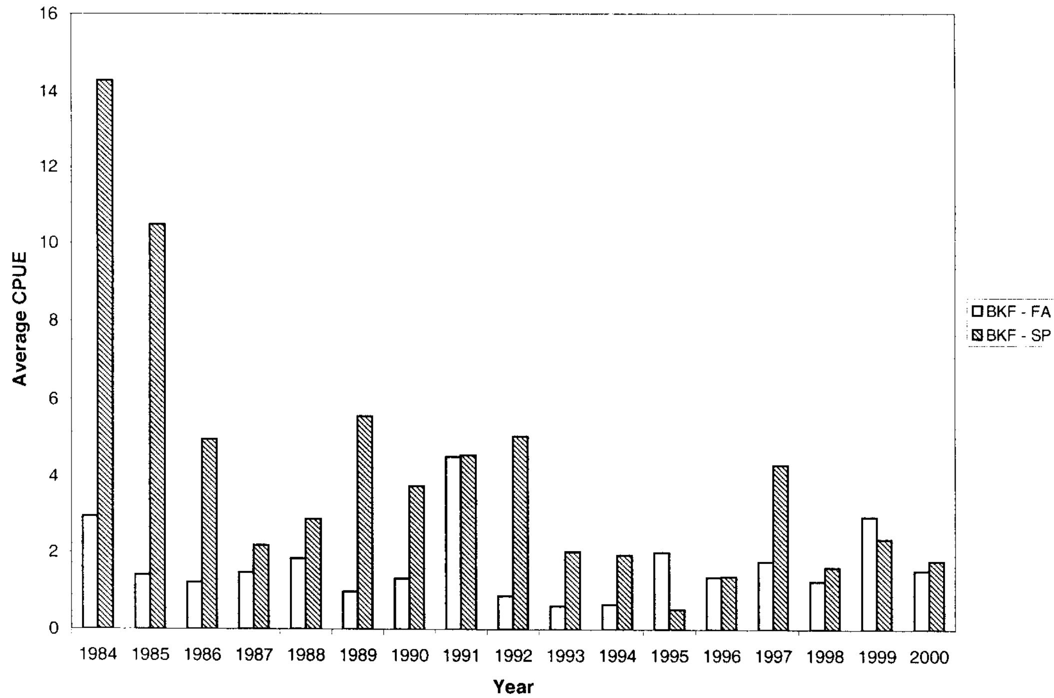


FIGURE 3.3-42 AVERAGE CPUE OF TAUTOG BY LOCATION AND SEASON 1984-2000

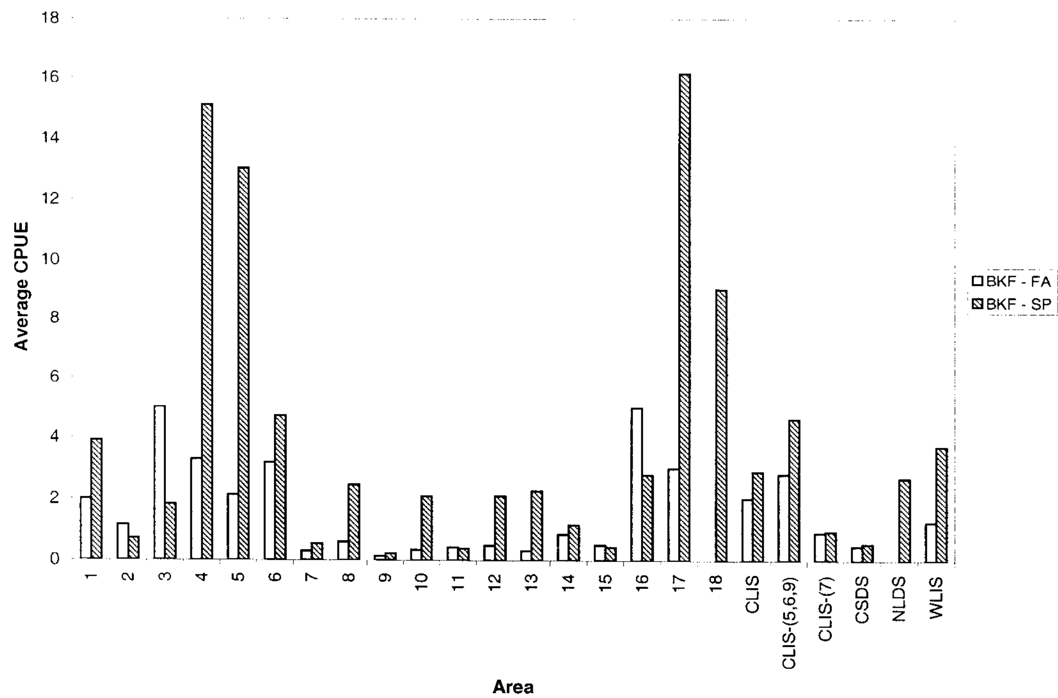


FIGURE 3.3-43 AVERAGE CPUE OF WEAKFISH BY YEAR AND SEASON 1984-2000

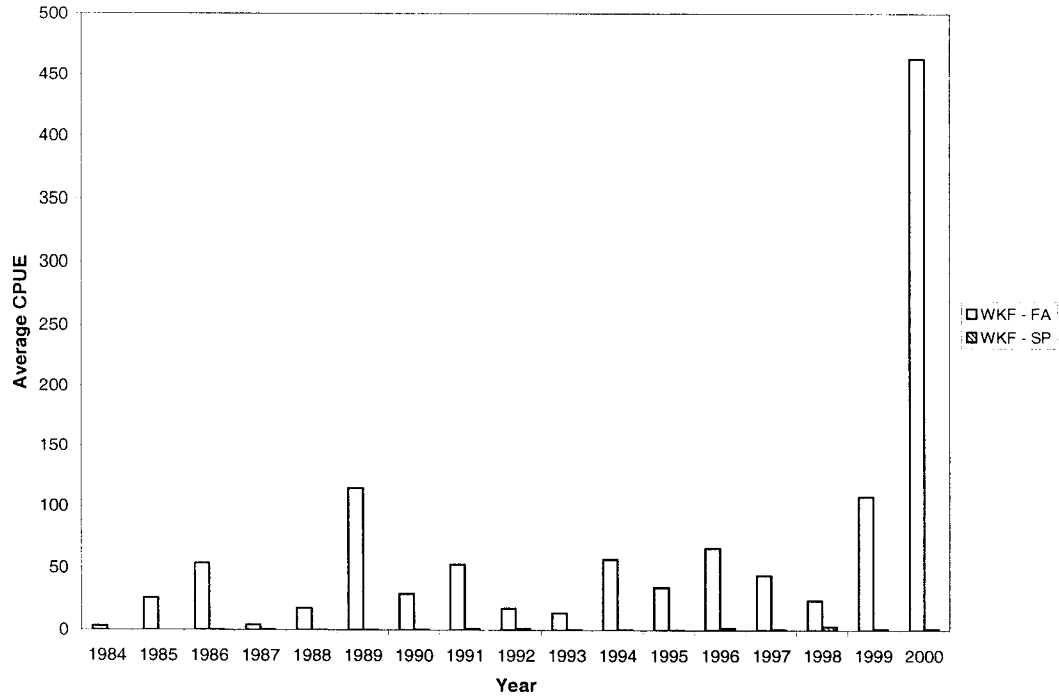


FIGURE 3.3-44 AVERAGE CPUE OF WEAKFISH BY LOCATION AND SEASON 1984-2000

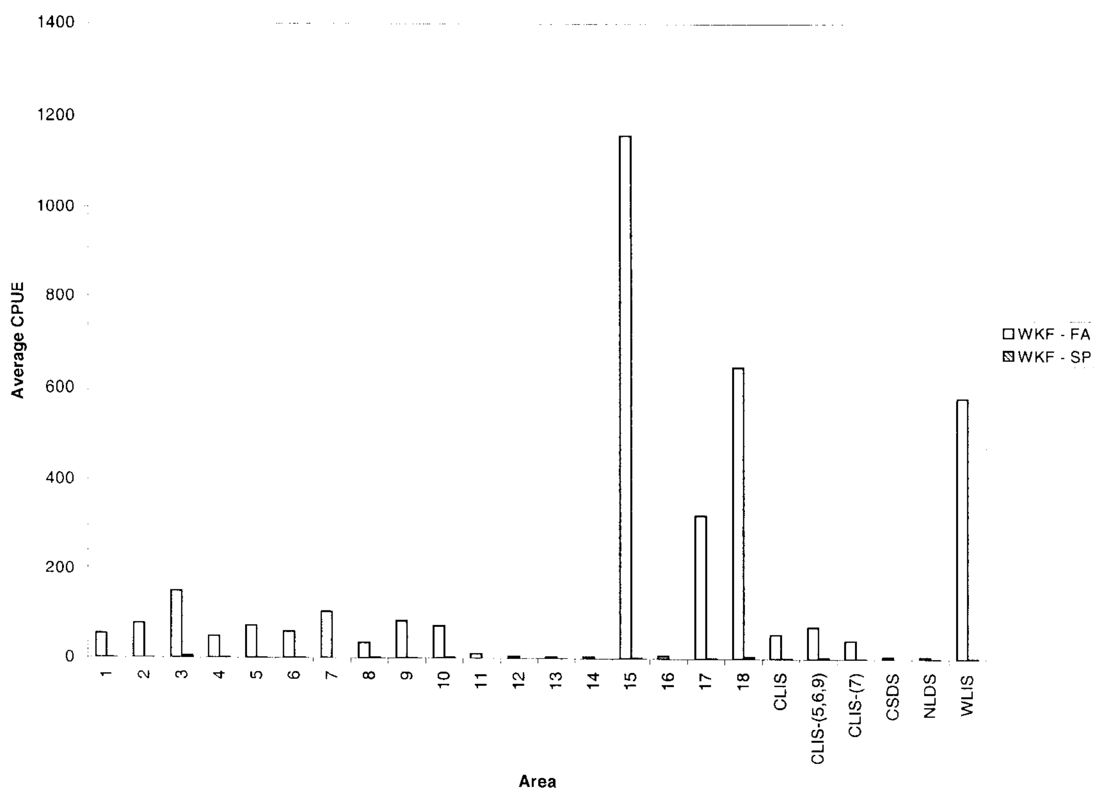


FIGURE 3.3-45 AVERAGE CPUE OF WINDOWPANE FLOUNDER BY YEAR AND SEASON 1984-2000

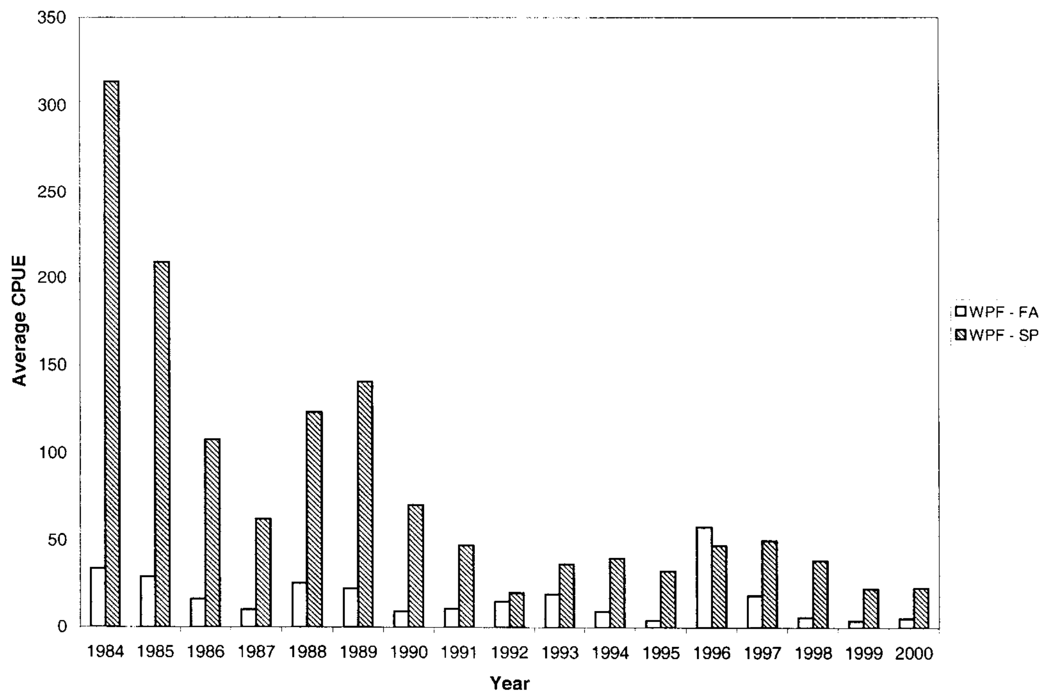


FIGURE 3.3-46 AVERAGE CPUE OF WINDOWPANE FLOUNDER BY LOCATION AND SEASON 1984-2000

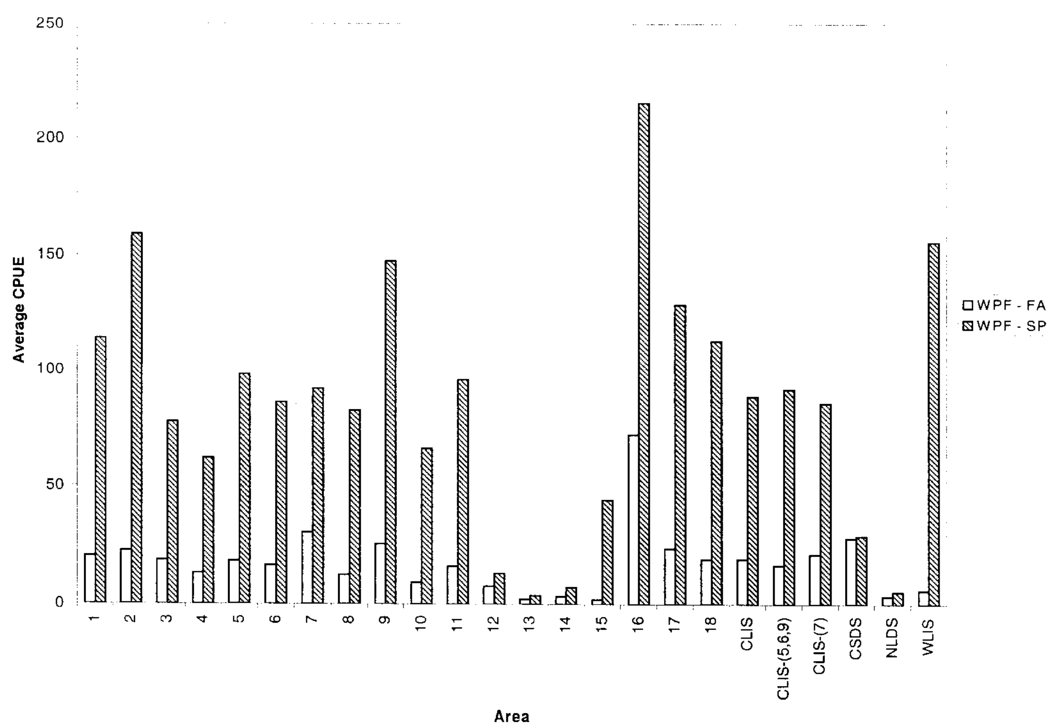


FIGURE 3.3-47 AVERAGE CPUE OF WINTER FLOUNDER BY YEAR AND SEASON 1984-2000

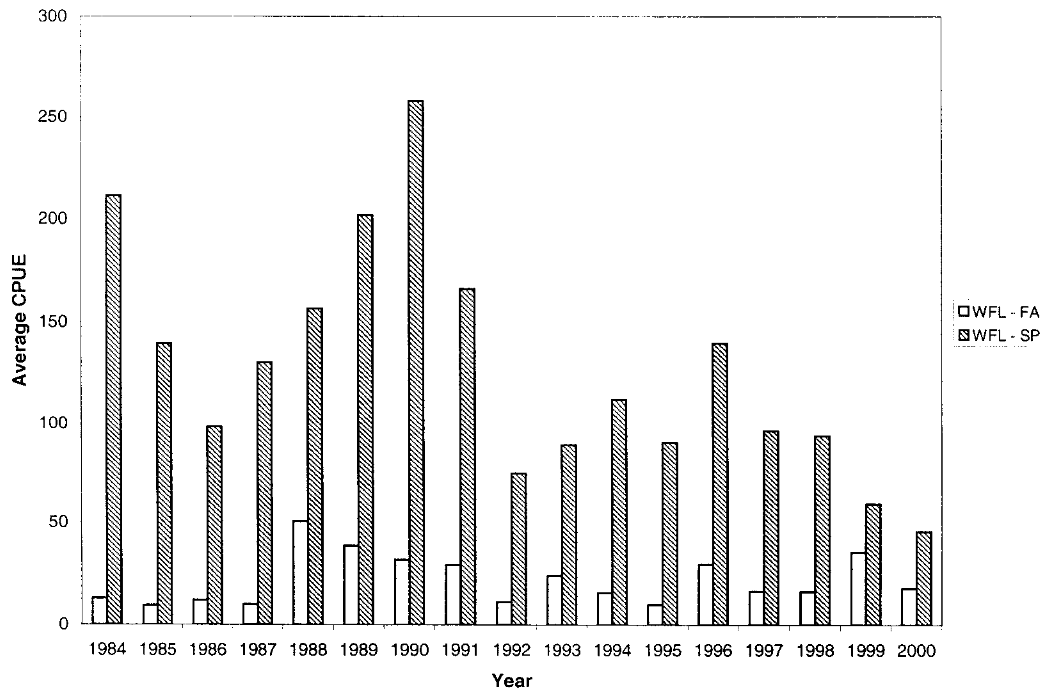


FIGURE 3.3-48 AVERAGE CPUE OF WINTER FLOUNDER BY LOCATION AND SEASON 1984-2000

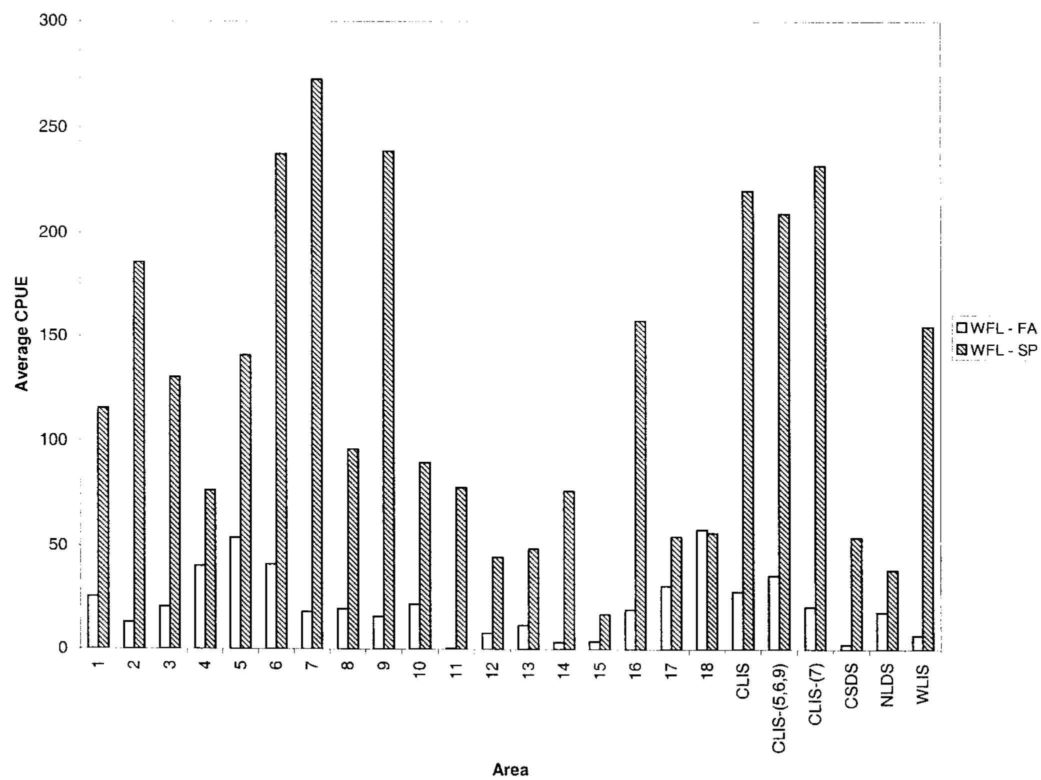


FIGURE 3.4-1 TOTAL HARVESTABLE CPUE BY YEAR AND SEASON

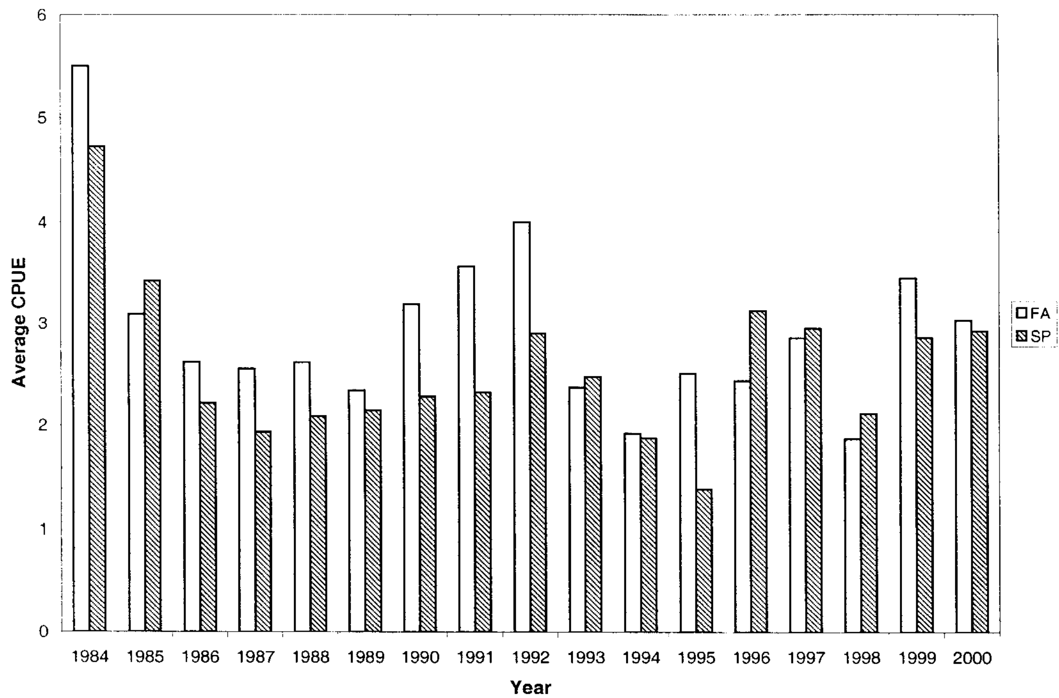


FIGURE 3.4-2 TOTAL HARVESTABLE CPUE BY LOCATION AND SEASON

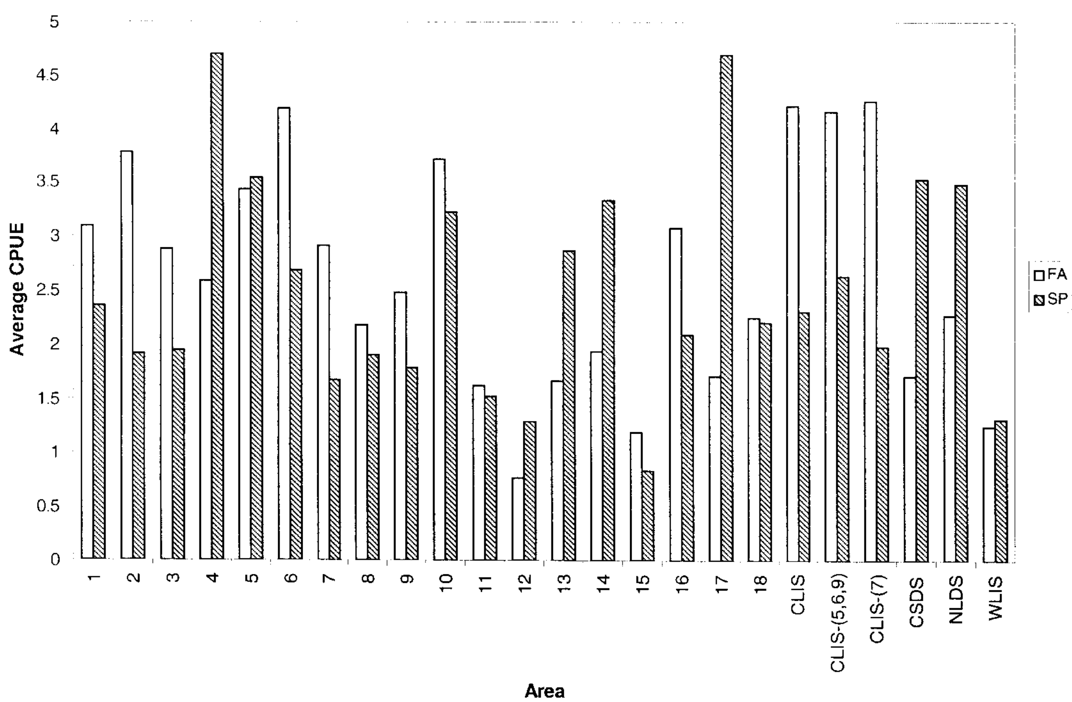


FIGURE 3.5-1 AVERAGE CPUE OF JUVENILE FINFISH BY LOCATION AND SEASON 1984-2000

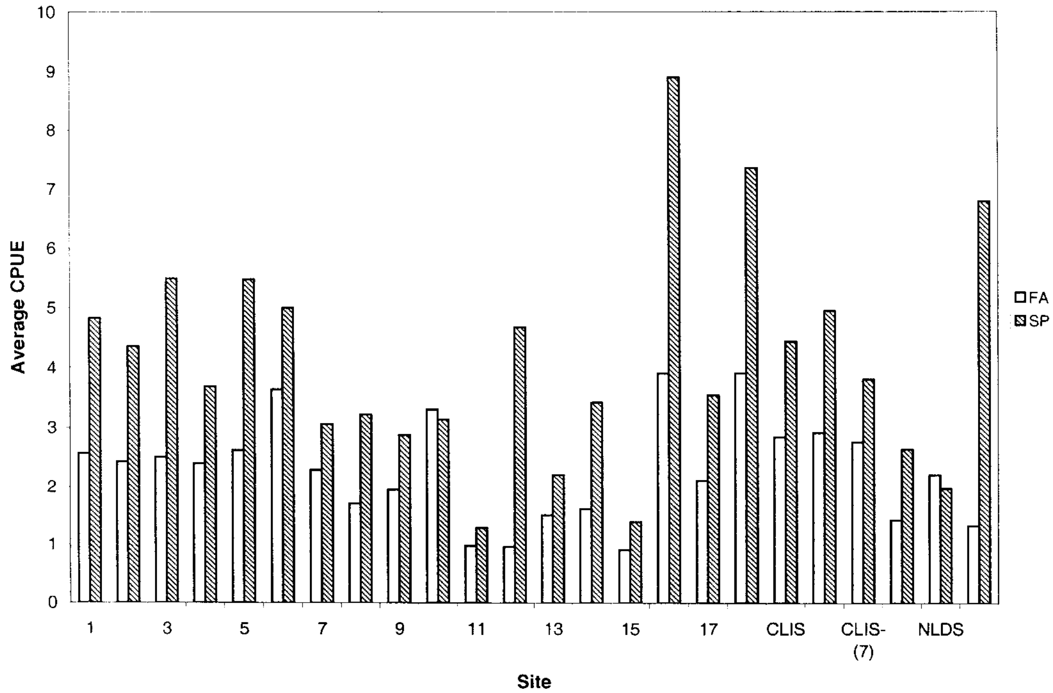
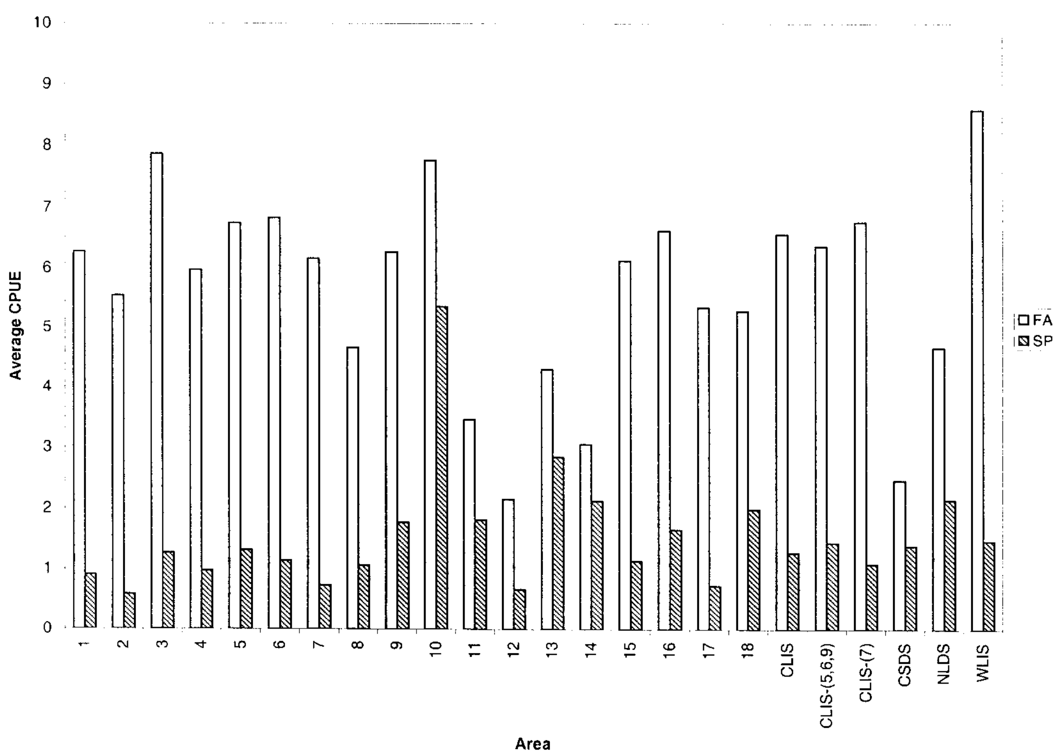


FIGURE 3.5-2 AVERAGE CPUE OF YOUNG-OF-THE-YEAR BY LOCATION AND SEASON 1984-2000



4.0 CONCLUSIONS

This data analysis was designed to serve two broad purposes. First, to provide baseline screening data of fish resources for site screening of potential dredged material disposal sites. Second, to provide data to evaluate potential impacts on fish resources at existing disposal sites based on historical use of these sites for dredged material disposal.

4.1 SITE SCREENING

The database structure provides Sound-wide screening data for Total CPUE, Richness and individual species CPUE. Many of the relationships and graphics presented in this report will be useful for prioritizing site screening layers and assigning weights. To conduct site screening outside of LIS, the available data from RIDEM and NMFS will need to be incorporated into a similar set of analyses. Harvestable CPUE and species CPUE of juvenile and YOY will be less useful on a Sound-wide basis because of the lack of data. However, there are broad areas of LIS that can be described as juvenile habitat area in addition to the areas described in this report (transitional habitat areas in Western Long Island Sound). This descriptive work should be done in consultation with fisheries experts in Connecticut and New York.

4.2 EVALUATION OF EXISTING DISPOSAL SITES

Two primary results of this analysis support assessment of existing disposal sites.

1. The baseline description of each site analysis area represents a reasonable potential impact zone for proposed dredged material disposal activities. The average CPUE, richness and dominant species for each analysis area provides a clear expectation of potentially affected resources for fall and spring disposal activities. These resources can be weighed against resources at other alternative sites to find the least environmentally damaging practicable alternative. This data analysis should be combined with the EFH report to produce an assessment of project impacts at any aquatic disposal alternative based on a scheme similar to the following. For each species, what is the:

    - Likelihood of presence in disposal sites?
    - Likelihood of presence during disposal activities?
    - Level of potential overlap (based on percentage of available habitat)?

    Level of potential overlap would be based on:

- None (no interaction)
- Minimal (transitory use only)
- Minor (may be feeding in area, but not during disposal activity)
- Major (known feeding or breeding area)

2. The comparison of disposal site analysis areas with adjacent habitat areas provides a direct assessment of overlap of finfish resources with historical disposal activities. Although this approach cannot isolate disposal impacts from other environmental and anthropogenic variables, it can localize any strong gradients in fish distribution and abundance and compare those gradients to recorded patterns of disposal in space and time.

The resources present around each existing disposal site are presented in detail in this report. In general, abundance and richness is high at the Central Long Island Sound Disposal Site, and low at all other disposal sites. Of these sites, Western Long Island Sound Disposal Site has a relatively low sample size limiting interpretation to a baseline measurement in 2000. New London Disposal Site also has low sample density but a much longer time series. Cornfield Shoals Disposal Site has high sample density but very low CPUE. The high abundance and richness at Central Long Island Disposal Site (CLIS) is typical of the large habitat area that surrounds the site. There is no indication that any of the sites has either depressed or enhanced trawlable fish resources compared to other areas of the Sound.

Based on average CPUE analyzed across years, seasons, and habitat areas, there was no evidence of a difference in catch from trawl stations located near dredged material disposal sites compared to adjacent habitat areas. Similar results were found for species richness and individual species CPUE. There is no evidence that annual patterns of disposal activity can be related to annual CPUE, richness or species CPUE (compare Figure 1.0-2 with Figures 3.2-1, 3.2-2, 3.2-3, 3.2-4).

The spatial distribution of CPUE, dominant species, and richness of finfish species within LIS and potential disposal sites has a complex pattern with seasonal variation. As a baseline characterization and tool for assessment of potential impact of disposal activities, the CTDEP data is more comprehensive and spatially detailed than any previous survey. While there are some limitations on characterizing specific areas of LIS, the detail available for CLIS provides a clear test of potential impact of disposal activities on long-term fish resources. It is never possible to account for all of the environmental variables that may influence spatial and temporal distribution of populations but if there were a strong gradient in impact (positive or negative) from these locations it should be apparent from the data associated with CLIS. This detailed spatial analysis failed to find any consistent differences between stations near active disposal sites and comparable habitat areas near the disposal sites.

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